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ABSTRACT

This special issue of the Mensa Research Journal contains four papers written by K. Warner Schaie, a psychologist who focuses on psychological development from young adulthood through old age. The first paper is "Living with Gerontology." In it, Schaie recounts his own childhood, adolescence, and young adulthood, his path to becoming a geropsychologist, origins of the Settle Longitudinal Study, his academic career at several major universities, and his major research interests. The second paper is titled "The Course of Adult Intellectual Development." It summarizes findings of the Seattle Longitudinal Study concerning: age at which decrements can be detected and magnitudes of age decrement; patterns and magnitude of generational differences; stability of psychometric ability structure; and reversing intellectual decline by educational interventions. The third paper, "The Impact of Longitudinal Studies on Understanding Development from Young Adulthood to Old Age," offers a theoretical framework and reviews longitudinal studies of adult development, and examines structural invariance of constructs across age, sources of individual differences, and developmental interventions. The last paper (co-written with Sherry L. Willis) is "Theories of Everyday Competence and Aging." It reviews different theoretical approaches to everyday competence, the role of methods of measurement in driving theories of competence, and everyday competence within a life span perspective. (Individual papers contain references.) (DB)

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A Tribute to K. Warner Schaie
Mensa Research Journal

Edited By
Phyllis Miller

Vol. 32, No.3, 2001

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Vol. 32, No. 3

A Tribute to K. Warner Schaie

Mensa Education & Research Foundation Lifetime Achievement Award Winner

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MENSA
Research Journal

Vol. 32, No. 3

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Editor's Preface

While I was preparing this issue of the *Mensa Research Journal*, my mother died. She was 89. A little more than a year ago, my husband's mother died. She was 95. Although both widows of the same generation, these two women could not have been more different, and I was especially struck by the difference in how they spent their last years.

My husband's mother lived in a senior residence in Florida. Meals were cooked for her, laundry was done for her, health care professionals made sure she took her medications. My mother insisted on living alone in the same New York City apartment she had lived in for the past 36 years. She shopped for her food, cooked it herself, did her own laundry, and took, or forgot to take, her own medicine. My husband's mother suffered from dementia and, at the end of her life, was oblivious to most of her surroundings. My mother, although she complained of failing memory, was still mentally sharp, and her stubborn independence was stronger than ever (do you detect the lament of the frustrated daughter here?).

So as I read these papers by Dr. K. Warner Schaie, I felt a special connection to his work and a special gratitude that he has devoted his career to the study of psychological development from young adulthood to advanced old age. So many scholars whose work has appeared in these pages concentrate their research on younger people; older folks seem to be overlooked. But Dr. Schaie, who almost single-handedly developed the field of geropsychology, has not overlooked this ever-growing segment of the population, and as the number of older people increases, so does the importance of his work. A pioneer in this field, as well as in the conduct of longitudinal studies, Dr. Schaie has provided information that is invaluable in setting public and social policy and in understanding our parents; our older colleagues, friends, and relatives; and ultimately ourselves.

For his body of scientific inquiry, for the influence he has had on shaping the field of geropsychology, and for the success of his many students in their own careers, Dr. Schaie has been named the recipient of the Mensa Education & Research Foundation Lifetime Achievement Award. He is only the second researcher to receive this award; the first was Dr. Julian Stanley of Johns Hopkins University, who developed the Search for Mathematically Precocious Youth and its many spinoffs. It seemed quite fitting to honor the first for his work with gifted youngsters and the second for his work with people at the opposite end of the life span.

This issue is devoted to the work of Dr. Schaie. And it is dedicated to my mother, Mary Hoffman, whom he would have enjoyed meeting.

Phyllis Miller
Editor

Living With Gerontology

K. Warner Schaie

This chapter describes how I came to be a gerontologist, or in my case, how I became intrigued with the study of psychological development from young adulthood to advanced old age. Inevitably, it is also an account of how my career became interwoven with a program of scientific inquiry conducted by me, my associates, and my students over the past 40 years that has come to be known as the Seattle Longitudinal Study (SLS; Schaie, 1996).

When I entered the field of gerontology in 1951, few people knew how to spell the name, let alone being able to offer a meaningful definition. Those who did would be most likely to respond to a young student interested in gerontology by asking, "Why do you want to worry about old people? Why not do something mainstream?" That was, for the most part, the response I received from my teachers and peers at the time. Hence, this autobiographical account also contributes to the story of how what once was considered an idiosyncratic interest eventually developed into a lifelong career that today nobody would doubt to be in the mainstream. Given the small number of early geropsychologists, I may have been privileged to have had at least some small influence on the progress of our field. For this opportunity I am very grateful to a number of teachers, colleagues, and students whose influences on my own scientific development I will attempt to trace in this chapter.

Childhood and Adolescence

I was born in 1928 in the town of Stettin, which then was the provincial capital of Pommerania, one of Germany's pre-World War II political subdivisions. My parents were Jewish middle class. My father and mother owned a small outfitters store for the then rapidly growing crowd of motor bikers. My native town was a sleepy provincial city of about 150,000 inhabitants (involved primarily in the garment industry, ship building, and fish processing) as well as a terminal for transferring grain and coal from the river barges to freighters that went to Scandinavia, Russia, and beyond. It was also a major garrison town, and as Germany rearmed the barracks multiplied and colorful parades were common. The big excitement for me was a visit to Berlin, which was an hour's train ride

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The program of research that has formed the scientific basis of much of my career, including preparation of this chapter, has been supported since 1963 by various grants from the National Institute of Mental Health and the National Institute on Aging. It is currently supported by research grant R37 AGO8055 from the National Institute on Aging.

Chapter 19, pp. 233-248, reprinted from *A History of Geropsychology in Autobiography* by J.E. Birren and J.J. Schroots, 2000.

away. We usually stayed with two of my grandmother's widowed sisters, my first intensive interaction with old people.

The Great Depression began in Europe shortly after I was born, probably the major reason why I remained an only child. Not very long thereafter the unemployment lines lengthened, the Weimar Republic went on a course of self-destruction, and Hitler and his Nazis soon took over. When I was 6 years old and the time came to start elementary school, I therefore attended a private school that had hastily been formed by the local Jewish community to protect its children from the daily harassment experienced in the public schools. I attended that school through the middle of fifth grade, learning enough basic skills such that I can still converse in German and write grammatically correct prose in that language, although my German is studded with archaic colloquialisms that were common in the 1930s.

While in the middle of fifth grade, there came Crystal Night (November 9, 1938), the systematic destruction of Jewish synagogues and stores by Nazi hooligans, as well as the incarceration of most Jewish men in concentration camps. My parents' store was destroyed, but my father was able to avoid being taken to a concentration camp by going into hiding. He now began desperately to seek a way for our family to leave Germany, because the likely consequences of our remaining had become convincingly clear. By that time hardly any country was willing to accept Jewish refugees from Germany. The question thus became primarily one of how to get out, regardless of where one might end up going. My father discovered that it was possible to book passage on an Italian cruise ship that plied a route through the Suez Canal, then around India and Malaysia, ending up in the port city of Shanghai, China.

In June 1939, my parents and I took the train from Stettin to Trieste (the two anchor points in Winston Churchill's famous iron curtain speech) and embarked, not really knowing where we would wind up. After several futile attempts to obtain permission to go ashore along the way we finally were allowed to enter Shanghai. At the time Shanghai was still an international settlement governed by the consular representatives of 17 nations that were signatories to the so-called unequal treaties. Through these treaties, during the 19th century, foreign concessions had been created on Chinese soil that were not subject to Chinese law. The reason we were allowed to land was primarily because of the fact that the amorphous local government had not been able to get its act together to keep us out!

The trip to the Far East and the bustling and exotic streets of Shanghai seemed high adventure to an 11-year-old. Hence, I gave little thought to the uncertain future facing my family. There was a large foreign population in Shanghai, with a substantial Jewish community that had settled there during the expansion of Western trade in China or who had taken refuge from the Bolshevik revolution in Russia after World War I. Some of these people had even acquired great wealth, and they formed charitable organizations that

attempted to provide shelter and food for all the refugees and education for the young. I attended a school for refugee children for about two years, acquiring English language competence and completing an educational program that would approximate that of an American junior high school. Then came Pearl Harbor, my English and American teachers were interned by the Japanese authorities, and at age 14 I became an involuntary high school dropout.

After the Japanese authorities made all the refugees relocate to a ghetto area, vocational options became quite restricted. I was fortunate enough to find a job as an apprentice in a small print shop, where I learned some typesetting skills. When the war ended in 1945 and the local English-language newspaper reopened, I managed to get a job in their print shop and learned how to use a Linotype machine and to typeset newspaper advertisements. The labor unions were already dominated by the communists, and they did not like a foreigner looking over their shoulder in the print shop; they soon forced me out.

During my final months in Shanghai, I had the opportunity to work as an untrained social worker with the American Joint Distribution Committee working with people about to be resettled in the United States. Here I first became intrigued with the infinite variety of individual differences in life experiences and reactions thereto, as well as in the resilience of adults in adapting to profound stresses and adapting to externally imposed changes of life conditions.

Young Adulthood

The communist armies were beginning to approach the gates of Shanghai. My father had died of a stroke in early 1947, and my mother was too distraught to actively participate in planning our future. Thus in 1947, I unilaterally decided it was time to resettle myself and my mother to the United States, and to our great relief we were able to leave Shanghai in November of that year on a former troop transporter (the SS *General Gordon*), arriving in San Francisco on December 17. I still vividly remember sailing under the Golden Gate Bridge in the morning fog, wondering what lay in store for me in a new country.

I have often been asked whether coming to San Francisco was a strange and stressful experience. My response has always been that, to the contrary, it seemed much more like a homecoming. Shanghai had presented us with the need to adapt to a totally different culture, within a strange environment, whose language and customs we did not understand, where water and many foods were unsafe, and many familiar foods were unavailable. By contrast, having acquired fluency in English, in San Francisco I could understand what everyone said. I could read all the signs, food and water were safe, and many of the conveniences of life we once knew were once again available to us.

After a week in San Francisco, I met with a caseworker from the agency that had sponsored our immigration to the United States to discuss the future. I was informed that the Eugene, Oregon, Jewish community had agreed to sponsor us

and that a job had been found for me as a busboy in a restaurant. I pondered for a minute or two. As a brash 19-year-old, I then revved up my courage to tell the caseworker that this plan didn't quite match what I had expected would be possible for me in America. I thanked her politely and told her that I would first see what I could do for myself during the next few days. Indeed, the next day I had found a minimum-wage job in a small print shop, and the following day I moved my mother and myself into a small apartment; I promptly informed our sponsors that I had completed resettling us and that their help was no longer needed.

My printing experience had served me well in making it easy to find my first American job and it continued to help. By the summer of 1948, I had managed first to move to a better paying job at a suburban newspaper and, after being admitted to the printer's union, was able to find work in the composing room of the *San Francisco Chronicle* typesetting and making up display advertisements. The *Chronicle* was and remains a morning newspaper, which means that printers typically work at night. Hence, there was little to occupy my afternoons. One day, placing some of the display advertisements into a newspaper page, I noticed a story on a high school program for adults at the local community college. Never having completed high school, on the spur of the moment I decided that it might not hurt me to have a high school diploma. I enrolled at City College of San Francisco, took courses in civics, American history, and chemistry, but was able to test out of most other requirements (including high school English) and obtained a diploma from the San Francisco Unified School District at the end of the first semester.

Becoming a Geropsychologist

It became very clear to me that I did not wish to seek a lifelong career as a printer and that I wanted somehow to become an educated person. But why did I choose to eventually enter geropsychology? As will become clear from this section, I started college primarily interested to embark in some social service field, but serendipity soon intervened, and by the end of my junior year it was almost certain that I had found my niche in the study of aging. Moreover, another serendipitous choice of the research population studied for my dissertation would point me toward centering on the aging of intellectual competence as my central academic concern.

The College Years

The environment at San Francisco City College was very pleasant. It was a great opportunity to make new friends, the work was stimulating but not unduly demanding, and I was well able to get it done even while holding a full-time job. Having gotten used to and liking the college setting, I decided to go on,

building my program of studies primarily around those courses that were offered in the afternoon so that I could sleep in the morning following my night shift as a printer. Because most science labs were offered in the morning, this meant that I was destined to concentrate on social science topics.

At City College I was influenced particularly by my English composition instructor, Donald Snepp, who with great patience helped me hone my writing skills and also exposed me to an understanding of the many metaphors in both classical and modern English and American literature that are the bane of the nonnative English speaker. Even more important was Ralph Granneberg, my instructor in the introductory courses in psychology and sociology, who first exposed me to principles of experimental psychology. He probably single-handedly convinced me that psychology was a science that should be taken seriously.

The California higher education system allowed automatic transfer to the state university system on graduation from junior college with a C average or better. Thus, after obtaining my AA, I transferred to Berkeley as a psychology major. Being a newcomer to the States, I really had not been fully aware of the world-class caliber of the University of California-Berkeley campus. Berkeley was an exciting place to be in the 1950s, and all of a sudden I found myself being taught by the people who had done the research and written the textbooks. Not only was the faculty outstanding and intellectually demanding, but the undergraduates were extremely competitive, and most of my smaller upper division classes had mixtures of graduate students as well. After some hairy times, more intensive work, and lower grades than I had come to expect at junior college, I managed to find my footing and made good use of my time.

The highlight of my first semester at Berkeley was an exciting tests and measurement course from Read Tuddenham, to whom I promptly shifted as my advisor. Once again I was having trouble building a full schedule confined to the afternoon. I therefore asked Tuddenham to do a directed study with him. Discussing various possibilities, I idly mentioned that I had thought his class discussion of Thurstone's (1938) primary mental abilities (PMA) work interesting, and wondered whether there had been any work done on the PMA in adults. As a good teacher, Tuddenham told me to go to the library and find out.

Thurstone in the 1930s had analyzed more than 60 measures of mental ability with large samples of children and adolescents in Chicago. Applying his new method of centroid factor analysis he discovered that individual differences on these measures could be accounted for by no more than 10 factors, which he thought of as the "building blocks of the mind." Thurstone published a formal test of the five most important of these ability factors. They were Verbal Meaning (a measure of recognition vocabulary), Space (a measure of being able to rotate abstract figures in two dimensional space), Reasoning (a measure of the ability to induce rules from common features of an activity), Number (a measure of addition skill), and Word Fluency (a measure of word recall).

A thorough search of *Psychological Abstracts* revealed that there were substantial data on children and adolescents but that nothing had been done with adults. Hence, I proposed a directed study to determine whether the low correlations among the different abilities reported in childhood would also prevail in adults. Tuddenham agreed that this was an interesting and appropriate question for a term project and told me to go ahead.

But where does an undergraduate find adult subjects beyond college age? As serendipity would have it, I was still being treated for the aftereffects of the malnutrition experienced during my Shanghai years. My family physician, Robert M. Perlman, happened to be interested in geriatrics. When I mentioned my subject problem to him, he offered to provide me with testing space in his practice and allowed me to recruit subjects in his waiting room. He also introduced me to Florence Vickery, then director of the San Francisco Senior Citizens' Center, one of the first to be established in the United States, who permitted me to recruit and test subjects at her facility. My first aging study was under way.

I was able to test several dozens of subjects ranging from the 20s to the 70s and found not only that the primary mental abilities remained distinct in adulthood but also that age differences were not identical for all abilities. As compared to the normative data for adolescents, it turned out that young adults and those in early middle age, on average, did better than the high school students. There were significant age differences thereafter, and in particular older adults did less well on Space and Reasoning than they did on their verbal and numeric skills. Administering the test to a subset of study participants under untimed conditions, further showed that the age difference patterns were even more pronounced when the speed restriction was removed.

While the data collection was proceeding, Dr. Perlman received an announcement for the Second International Congress of Gerontology to be held in St. Louis, Missouri. He suggested that I submit a proposal for a convention paper with him as a coauthor. The paper was accepted, but in order to report respectable statistics I now had to recruit a friend, Fred Rosenthal, who was a semester ahead of me, to run the t-tests that I had not yet mastered. Thus, in August of 1951, I mounted the Greyhound bus for my first long American trip to go to St. Louis for the Congress.

Gerontology was still a very small affair and the Second International Congress had about 200 registrants, two thirds of whom were Americans. Perhaps no more than 30 participants were psychologists. I do not remember much about the scientific sessions, but I vividly recall meeting many of the founders of geropsychology, including James Birren, Robert Kleemeier, Irving Lorge, and Robert Havighurst. This was very heady stuff for a college junior, and I was even more excited when the editor of the *Journal of Gerontology*, John Esben Kirk, invited me to submit my paper, titled "Differential Deterioration of Factorially 'Pure' Mental Abilities," as a journal article and

promptly accepted it (Schaie, Rosenthal, & Penman, 1953). My entry into adult developmental psychology and gerontology was obviously determined by these events.

During my last semester at Berkeley I did some more reading on individual differences and became interested in the concepts of behavioral rigidity and perseveration studied by psychologists such as Kurt Lewin, Abraham Luchins, Jacob Kounin, and Charles Spearman. They suggested that the boundaries between different domains of behavior would rigidify with age, and that there would be increasing interference in shifting away from old and no longer appropriate strategies to the adoption of new and more appropriate problem-solving strategies. If this was the case, I thought that perhaps age differences in the primary mental abilities might well be explained by a progressive reduction in cognitive functions for those who were more rigid to begin with or who became less flexible as they aged. I attempted to test this proposition in another directed study, but although the effort was too ambitious to succeed then, it became the basis of my research in graduate school.

Graduate School

With my Berkeley experience coming to an end, I now turned to apply to graduate programs. Cocky as ever, I unrealistically considered only the top schools. Rejections from Berkeley, Stanford, Michigan, and Harvard put me in my place. But my backup, the University of Washington, came through. I suspect that the article in press in the *Journal of Gerontology* probably helped get me accepted into the University of Washington clinical psychology program. In the fall of 1952, I therefore headed north to Seattle, actually the first time I had been entirely on my own. The psychology department had not committed any financial support, quite usual for the time, and so once again I supported myself by working as a nighttime printer in the composing room of the *Seattle Post-Intelligencer*.

In contrast to most of my classmates, I early on had found an intellectual niche in geropsychology and I also had a set of specific research objectives at the very beginning of my graduate training. In addition to obtaining the necessary clinical training to become an academic clinical psychologist, I wanted to focus my research on the interesting puzzle of why it is that some people maintain their intellectual powers into old age while others begin to decline at an early adult stage. I did not realize at the time, of course, that I was posing a challenge, the response to which would occupy my entire career.

Having had excellent preparation in the conventional statistical methods at Berkeley, I was able to skip the usual first-year methods sequence and immerse myself directly into multivariate and factor analysis (Paul Horst) as well as scaling methods (Allen Edwards) and Q-methodology (William Stephenson was a visiting professor that year). I was thus ready to begin instrument development

to provide me with formal operations that would measure the rigidity-flexibility concept I had become interested in at Berkeley as a possible explanatory variable for individual differences in cognitive aging. From the research literature I identified a set of 10 potentially appropriate measures of the construct of rigidity-flexibility that I adapted for use with a population ranging in age from young adulthood to old age. I was able to test about 300 subjects in several months' work and was then ready to conduct a multiple group factor analysis (on a Monroe desk calculator!), in which I showed that the different measures of rigidity-flexibility could be represented as a three-factor structure. I replicated the factor solution on another sample and eventually published this material as the Test of Behavioral Rigidity. This work was accepted by the end of 1953 as my MS thesis (directed by Charles Strother, Paul Horst, and Sidney Bijou).

Returning home to San Francisco for the summer of 1953, I married my first wife, Coloma John Harrison, whom I had met at a leap-year party in San Francisco the previous year. During the summer I also attended sessions of the annual meeting of the Gerontological Society in San Francisco, which I had earlier joined as a student member; that year I also became a student member of the American Psychological Association (APA).

It is important to note here that no one on the Washington psychology faculty was particularly interested in adult development or aging, and it was necessary therefore to create my own academic support system. At the 1953 Gerontological Society of America (GSA) meeting I sought advice from some of the people I had met earlier at the St. Louis congress, notably Harold Jones and a University of Washington academic physician, K. K. Sherwood. Returning to campus in the fall, I also discovered a latent interest in gerontology in a number of other departments, and I was able to convince the dean of the graduate school to sponsor a Committee on Gerontology, which my advisor, Charles R. Strother, the director of clinical training, generously agreed to chair, even though he was not particularly interested in aging. Other active members of this committee were Joseph Cohen (a sociologist interested in elder housing, who later on became the outside member of my dissertation committee); Norman Kunde (an exercise physiologist); Robert Lampman (a labor economist); and Victor Howery (then dean of the School of Social Work). The committee needed an executive secretary and in the fall of 1953, I was finally able to give up working nights as a newspaper printer, as I now received fellowship support (from one of the first National Institute of Mental Health [NIMH] institutional training grants in clinical psychology) in return for agreeing to staff the new committee as well as pursuing my own research on aging.

To focus the work of the new committee, I proposed an intensive study of a group of well-functioning elders that not only would encompass psychological variables but would include an examination of health status, physical activities, and environmental contexts. A small grant from the University of Washington research council to Charles Strother permitted the recruitment of 25 men and 25

women over the age of 70 years who had completed a college degree or beyond. This work occupied much of my third year of graduate study, as well as the completion of a rigorous set of the then in vogue broad comprehensive examinations across the entire breadth of psychology.

As would not surprise us today, the advantaged group of elderly still maintained high levels of functioning and activity on virtually all of our measures. Several reports emerged from this study, the first presented at the 1955 APA meeting in San Francisco. This meeting was important also because it presented an opportunity to renew my acquaintance with James Birren and to start a friendship and many professional collaborations that have lasted to this day.

Other activities initiated by me under the auspices of the University of Washington Committee on Gerontology included a Northwest Conference on Aging in 1954 that, among others, brought Wilma Donahue and Clark Tibbits to campus. There were also talks on gerontology to local professional groups, and in 1955 I organized and led the first gerontology course ever offered at the University of Washington, supported by the continuing education division and staffed by members of the Committee on Aging. About that time, I also became a full member of the American Psychological Association and of the Gerontological Society.

Origins of the Seattle Longitudinal Study

Having passed my comprehensive examinations, it became time to propose a dissertation project. My mentor tried to interest me in taking a critical incidents approach (a la Flanagan) to the study of the process of psychoanalysis at a pioneering hospital for adolescent schizophrenics at which he was a consultant. After several months it became clear that whatever observational or descriptive scheme I proposed the analysts perceived as effectively changing the process! I was therefore allowed to return to my primary interest, which was to put together my pilot work on rigidity-flexibility and intelligence. As serendipity would have it, Charles Strother, my advisor, had just been named chair of the lay board of trustees of the Group Health Cooperative of Puget Sound, one of America's first (and now one of the largest) health maintenance organizations (HMOs). The HMO was interested in doing a consumer satisfaction survey but had neither staff nor financial resources to allocate. A deal was struck. I was allowed to collect my dissertation data on a random sample of the adult HMO membership under the condition that I conduct the consumer satisfaction survey at the same time. Other members of my doctoral committee included Paul Horst (who as a student of L. L. Thurstone was very sympathetic to my work and provided most of the methodological guidance), Sydney Bijou, George Horton, and Joseph Cohen as outside member. At the last minute my department head, Roger Brown Loucks, added himself to the committee to make sure, in his words "that I wasn't going to get away with something."

I randomly selected about 3000 persons evenly spaced across the age range from 20 to 70 years and administered the Thurstone Primary Mental Abilities (PMA) test and my own rigidity-flexibility test (the TBR) until I had assessed 25 men and 25 women in each five-year interval. I was able to replicate my earlier findings on differential patterns of age differences in intelligence by ability as well as to show that peak ages of performance had risen since the earlier work by Wechsler and others and were now to be found in the 30s or even later. Substantial positive correlations were also found between rigidity-flexibility and the ability measures, but I did not find the predicted causal relationship; that, as it turned out, required longitudinal data (Schaie, 1958).

Postdoctoral Training

When I obtained my doctoral degree in 1956 there were no employment opportunities for someone who wanted to specialize in gerontology. My mentor therefore advised me to strengthen my clinical skills through a year of postdoctoral study and then seek employment as an academic clinician. This was accomplished at Washington University in St. Louis, then an important place in the development of gerontology. There I had the opportunity to do some research with James Weiss (later chair of psychiatry at the University of Missouri), who then directed the Washington University Psychiatric Outpatient Clinic, to develop a Q-sort instrument assessing the attributes of complaints that brought older patients to the clinic, reinforcing my interest in older populations.

My Academic Career

It was now time to enter academia. My postdoctoral training had prepared me for then-burgeoning opportunities in academic clinical psychology. As will be described in this section, I began my career focusing on psychological assessment in adults, but soon was able to return to basic research in the development of adult psychological competence as well as the formulation of novel longitudinal research methodologies. Although my first academic position was that of a traditional teacher/researcher, my career has also heavily involved academic and research administration, from the very beginning focused on interdisciplinary efforts related to the study of aging.

The University of Nebraska, Lincoln

In the summer of 1957, Marshall R. Jones offered me an appointment as assistant professor at the University of Nebraska to teach adult cognitive and personality assessment and to supervise students in the psychology clinic associated with the clinical training program. In this context my interests turned to issues of objective psychological assessment. A visit by Raymond Cattell to

speak at the Nebraska Symposium on Motivation aroused my interest in unobtrusive personality measurement. The work with Weiss on defining symptoms that bring patients to the clinic was also continued off and on through 1960, during which year my son Stephan was born. That year I also passed the ABEPP examination in clinical psychology and was promoted to associate professor.

During my last days in St. Louis I met my successor as a postdoctoral fellow, Ottfried Spreen, who returned to Germany to lead a new clinical psychology section at the University of Saarbrucken. The psychology department had received the gift of a first-generation computer (the IBM 650) from a steel company that was upgrading its equipment. Spreen knew that I had some computer skills, and in the summer of 1961 he asked me to help him and his colleagues to think through how to use this computer.

At Saarbrucken I met Gunther Reiner (later founding chair of the psychology department at the University of Trier) who was then the chief scientific assistant to Egon Boesch (the department head). Reinert introduced me to his mentor at the University of Freiburg, Robert Heiss, who had done a lot of work with a color preference test, the Color Pyramid Test (Farbpyramiden-test), first introduced by the Swiss psychologist Hans Pfister. This test seemed to offer an unobtrusive method for objective personality assessment via the relation of color and personality. On returning to Nebraska, I began to study schoolchildren as well as mentally retarded and mentally ill persons in state institutions. This work led to my first book, *Color and Personality* (Schaie & Heiss, 1964).

Although the work on color and personality almost let me to abandon my interest in gerontology, it incidentally also led to the inception of my long-standing friendship and collegial association with Paul and Margret Baltes. Gunther Reinert wrote me that he had a promising young student who he thought could use some American experience. I was able to get a research assistantship for Paul for the purpose of collecting color pyramid data in Nebraska schools. He and Margret joined me during my final year at Nebraska (1963-1964), and Margret began working for me as an assistant and secretary when the first Seattle Longitudinal Study (SLS) follow-up was funded.

Converting a Cross-Sectional to a Longitudinal Study

It took me a long time to convince my Nebraska colleagues to use my training in developmental psychology. But in my fourth year at Nebraska, I was finally asked to teach the developmental section of the departmental proseminar and was allowed to introduce a unit on adult development. In preparing for that seminar, I was confronted with addressing the discrepancies between cross-sectional and longitudinal findings in the study of adult intellectual development. I soon became convinced that this issue needed to be addressed by following a structured cross-sectional sample over time, such as the one that I had collected for my dissertation. I therefore designed a follow-up inquiry that converted my

original cross-sectional study of cognitive aging into a series of short-term longitudinal studies, each extending over the same seven-year period. My graduate school mentor, Charles Strother, then at the height of his professional career, graciously agreed to front for me as principal investigator. Funding for the study was received from the National Institute of Mental Health, and with the continuing cooperation of the HMO, I went into the field in 1963 to conduct this follow-up. Additionally, I drew a new random sample from the HMO membership that permitted comparison of panels tested at the same age but at different times (known as "Schaie's most efficient design"). Thus the Seattle Longitudinal Study (SLS) was now in place and I was once again firmly entrenched in geropsychology!

The second cross-sectional study (1963) essentially replicated the findings of the base study. The short-term longitudinal study, however, disclosed substantially different information about peak levels and rate of decline. Publication of findings was therefore delayed until a theoretical model could be built that accounted for the discrepancy between the longitudinal and cross-sectional data. These analyses suggested that comparisons of age group means needed to be conducted for the repeatedly measured samples as well as for successive independent samples drawn from the same cohort.

Results were reported that called attention to substantial cohort differences and that questioned the universality and significance of intellectual decrement with advancing age in community-dwelling persons. While the cross-sectional data implied peaks in early adulthood with decline beginning in middle age and becoming severe as the 60s are reached, the longitudinal data, by contrast, suggested little age-related decline before the 60s and only modest decline during the 70s.

The first longitudinal follow-up of the SLS provided some answers but it also raised sufficient methodological and substantive questions to initiate a continuing program of studies (by now including seven major and several collateral data collections) that is still in progress. The longitudinal research program was first supported by the NIMH, has been continuously supported by the National Institute on Aging since 1970 and is currently funded to continue through 2004. The initial follow-up was also instrumental in forming my methodological efforts in understanding the relationship between cross-sectional and longitudinal data sets, which led to an influential *Psychological Bulletin* article (Schaie, 1965) that for many years has been required reading for geropsychology graduate students.

West Virginia University

An opportunity arose for me in 1964 to use my academic clinical skills to organize a clinical training program at West Virginia University. I was rather skeptical at first about a move to Appalachia. But a visit in May, when the

grime of the coal mining communities is hidden by the lush greenery of the Appalachian spring, and a university president (Paul Miller, who later became assistant secretary of education) with a vision to move his sleepy state university into modern times, convinced me. After a summer spent on the University of Washington campus to tie up the longitudinal follow-up, I thus moved to Morgantown, West Virginia. With the help of an NIMH development grant, I was able to bring the clinical psychology effort forward to APA accreditation, helped the first set of PhD candidates finish, and put in place a working relationship with the region's VA hospitals. I was also able to bring in some contract research with the National Center for Health Statistics to help support graduate students.

In 1965 Stanley Ikenberry (until recently president of the University of Illinois and now president of the American Council on Education), who had just become dean of a new College of Human Resources and Education, asked me to be the founding director of a Human Resources Research Institute whose mission was to provide intellectual links between his college and the traditional social science disciplines in the College of Arts and Sciences. In the context of this institute I oversaw research on the effects of the community action programs sponsored by Lyndon Johnson's "war on poverty" as well as statewide evaluations of the effects of early Headstart programs. With respect to adult development I was able to organize an international seminar for the study of social change in mining communities with meetings in Morgantown and Saarbrucken.

More important with respect to gerontology, I was able to conceptualize and receive funding for one of the first institutional training grants awarded by the National Institute on Child and Human Development (NICHD) to develop the concept of training in life-span developmental psychology. I had talked earlier with James Birren (then the aging section program officer in NICHD) about developing a training grant in geropsychology, but he had cautioned me on the need to first gain greater faculty depth. Thinking back to my early conversations with the developmentalists at Berkeley as well as having read some of the work of Charlotte Buhler, I thought that it might be propitious to reintroduce the concept of life-span development in the United States. Moreover, if I could combine faculty interested in child, adolescent, and adult development, I would then have a critical faculty mass on which to base a credible application.

I also wrote a conference grant application (modeled after my experience with the Nebraska Symposium on Motivation) with the support of APA's Division 20 (Adult Development and Aging). This conference, held in 1967, had specialists in geropsychology review the literature in core topics of the field, with critiques provided by substantively relevant psychologists who were studying children or adolescents. The conference and the publication arising therefrom was the predecessor of the series of conferences and monographs known

as the West Virginia Life-Span Series, which is still continuing under the guidance of Hayne Reese. That year I was also promoted to full professor.

In 1968 I was prevailed on to "simplify" my life by becoming chair of the Department of Psychology, in which role I served until 1973. One of my first acts as chair was to recruit Paul Baltes and John Nesselroade to join the departmental faculty and to take an active interest in geropsychology. Both Paul Baltes (now a director of the Berlin Max Planck Institute for Education and Development) and John Nesselroade (now professor of psychology at the University of Virginia) have continued this interest, both men eventually serving as presidents of APA's Division 20.

Next I once again returned to the study of adult cognitive development. Soon after the completion of the first longitudinal follow-up it had become evident that conclusions based on data covering a single seven-year interval required further replication, if only because two occasions of measurement permit the examination of cross-sectional but not of longitudinal sequences (the latter requiring a minimum of three measurement occasions). Only longitudinal sequences allow designs that permit contrasting age and cohort effects. Hence, plans were made for a third data collection, conducted in 1970. The results from the third data collection seemed rather definitive in replicating the short-term longitudinal findings, but they also showed further progression of the ability-related cohort trends discovered earlier (Schaie & Labouvie-Vief, 1974). This research marked a close association with Barbara Buech, whom I had recruited during the Saarbrucken mining conference and who became my Seattle field office coordinator, and with Gisela Labouvie-Vief, my chief research assistant (now professor of psychology at Wayne State University).

The University of Southern California

The heady expansion days financed by the Great Society programs and other endeavors to develop the Appalachian region had come to a close, and a new conservative university president began to talk about retrenchment and his perception that West Virginia could not afford a first-rate university. Having brought the psychology program to a nationally recognized level, I was not willing to preside over its return to mediocrity and decided that it was time to move on. At the same time, my first marriage had deteriorated to the point where a decision to bring it to an end had become inevitable, and a new beginning was needed as well to reinvigorate my personal life.

My old friend James Birren had founded the Andrus Gerontology Center at the University of Southern California in 1965. In 1973 he invited me to join him as associate director for research (later director of the Gerontology Research Institute) and as professor of psychology. At USC, I directed the interdisciplinary doctoral training program in aging and was instrumental in developing and overseeing a number of project-program efforts to bring to bear the skills of sci-

entists in the biological, behavioral, and social sciences on major basic issues in the aging process.

Discrepancies between findings in the repeated-measurement and independent-sampling studies suggested the need for a replication of the 14-year longitudinal sequences, and it also seemed useful to follow the original sample over as long as 21 years. A fourth data collection was therefore conducted in 1977. Continuous funding also made possible addressing a number of other bothersome questions. These included analyses of the consequences of shifting from a sampling without replacement model to a sampling with replacement paradigm, an analysis of the effects of monetary incentives on participant characteristics, an examination of the aging of tests, as well as causal analyses of health and environmental factors on change or maintenance of adult intellectual performance. Doctoral students who participated in this round of the SLS and who have continued to be active in geropsychology included Christopher Hertzog (now professor of psychology at the Georgia Institute of Technology), Margaret Quayhagen, and Michael Gilewski.

At USC I also started a new longitudinal study of cognitive aging (including memory functioning), which I followed only over a three-year period but which is now being continued by another of my former USC students, Elizabeth Zelinski. Beyond the research area, I was able to make an impact on many budding gerontologists by routinely teaching the course on research methods in aging that was part of the annual USC gerontology summer institutes. I was also involved in helping organize the Leonard Davis School of Gerontology, the first of its kind, and was active chairing committees for the recruitment of its first director and psychology faculty. In many ways, both the environment at the Andrus Gerontology Center and the gentle but intellectually stimulating leadership of Jim Birren helped me broaden my understanding of the role of geropsychology within the larger context of the study of aging and convinced me even more that interdisciplinary efforts in our field are a necessity, rather than a luxury.

The Pennsylvania State University

While at USC I had met Sherry Willis, who taught at the Pennsylvania State University. As our personal and professional interests began to merge, we decided that we should give up transcontinental commuting and be at the same institution. I therefore left USC at the end of 1981 to accept an appointment as professor of Human Development and Psychology at Penn State and to marry Sherry. Since 1985 I have directed the Penn State Gerontology Center, and in 1986 I was honored by the university with an appointment as the Evan Pugh Professor of Human Development and Psychology.

The fifth (1984) SLS cycle also marked the assumption of a major role in the study by Sherry Willis, who brought her skills in designing and implementing cognitive training paradigms. A major part of the fifth cycle was therefore

devoted to the implementation of a cognitive training study with our long-term participants aged 64 years or older. This study was designed to determine whether cognitive training in the elderly remediates cognitive decline or whether it increases levels of skill beyond those attained at earlier ages. In this study we found that almost two thirds of all subjects benefited significantly from a five-hour cognitive training program and that 40% of those who had reliably declined could be brought back to the performance level they had shown 14 years earlier. Training was also shown to remove the so reliably demonstrated gender difference on spatial orientation.

From the beginning of the SLS we had followed what was then the conventional wisdom of assessing each primary ability with that observable marker variable, which was thought to be the most reliable and valid measure of a particular ability. With the widespread introduction of modern methods of confirmatory (restricted) factor analysis, it became obvious that we needed to extend our concern with changes in level of intellectual functioning in adulthood to the assessment of structural relationships within the ability domain. This concern argued for collecting further data with a much expanded battery in which each ability would be multiply marked. Finally, this cycle saw the introduction of measures of practical intelligence, analyses of marital assortativity using data on married couples followed over as long as 21 years, and the application of event history methods to hazard analysis of cognitive change with age.

Penn State has had a long history of scientific and educational efforts in gerontology. The Penn State Gerontology Center was founded by Joseph Britton in 1967, with an interdisciplinary training grant supported successively by NIMH, NICHD, and since its inception by the National Institute on Aging (NIA), which has now been continuously in place for more than 30 years. The Gerontology Center had concentrated for a number of years on training service providers for local and state agencies. My early efforts were to refocus on research and education. These efforts included putting in place a pilot study support program for new faculty, the development of an annual research conference (known as the Social Structures and Aging series) with published proceedings, the showcasing of faculty by means of a reprint-preprint service, and by encouraging efforts to broaden the extramural funding for research related to aging. Of great help and continuing collegial support has been my assistant director Steven Zarit, whom I had originally recruited to USC and persuaded to follow me to Penn State.

In the education area we put in place graduate and undergraduate minors in gerontology and have been supportive of training teachers at small colleges by encouraging visiting appointments and being active in support of teaching workshops sponsored by Association of Gerontology in Higher Education (AGHE). I have also been active in encouraging regional cooperation through efforts such as the joint exhibit of Pennsylvania gerontology centers at professional meetings and participating in a consortium with Temple University and the University of

Pittsburgh in operating the Pennsylvania Geriatric Education Center, which offer continuing professional education over a wide spectrum of health-related professions. Current efforts include entry into the world of the Internet, trying to share Penn State's aging-related resources with the broader community.

Returning to my own scientific odyssey, I began a new cycle in 1991 that markedly expanded the scope of the SLS. First, with the collaboration of Robert Plomin, a noted developmental behavior geneticist, we began a study of cognitive family resemblance in adulthood. We did this by recruiting the participation of a large number of adult offspring and siblings of our longitudinal panel members. Second, we abstracted health histories on our panel members and have conducted detailed investigations of the relationship between health and maintenance of intellectual functioning, showing both the influence of chronic disease on maintenance of intellectual functioning and the importance of intellectual competence in postponing the onset of chronic disease. Third, we conducted a seven-year follow-up on the cognitive training study, showing continuing effects of the training intervention, and replicated the initial findings with a more recent cohort of older persons. Fourth, with the first longitudinal replication of our expanded test battery, we were able to conduct longitudinal analyses of cognitive ability structures, demonstrating the greater stability of longitudinal data, and further update our normative data.

Most recently, I have been able (with support from the NIA) to broaden my interdisciplinary interest even farther through new collaborative studies with the University of Washington Alzheimer Center and Department of Pathology, to study genetic markers in our longitudinal subjects, to investigate the relationship between our measurement system for the study of normal aging with the diagnostic procedures used by neuropsychologists interested in diagnosing dementias, and the relation of predeath behavioral correlates of eventual structural changes in the brain.

Other Influences

I should be remiss in not acknowledging the important role of international experiences in my professional development. Given the international scope of gerontology I always learned much from attending international congresses, such as the International Congress of Gerontology or the International Society for the Study of Behavioral Development. My German language skills were useful in accessing important professional relationships in the German-speaking countries, once I was able to resolve my feelings about the injuries of the past. I spent interesting sabbatical years as the University of Trier and the University of Bern, as well as at the Gerontological Center of Lund, Sweden. Most stimulating also was a year at the Center for Advanced Studies in the Behavioral Sciences at Stanford, California.

What Have I Learned as a Geropsychologist?

As part of my scientific work, I have been able to chart the course of selected psychometric abilities from young adulthood through old age. An important contribution of this work has been the detection of substantial generational differences in intellectual performance. Also identified were a number of contextual, health, and personality variables that offer explanations for differential age change and that provide a basis for possible interventions. Cognitive interventions were designed that have been successful in remediating carefully documented declines and that have improved the cognitive functions of many older persons who have remained stable. I have also studied changes in cognitive ability structures across age and different cohorts, have conducted analyses of the relative effect of speed and accuracy in age decline and training gain, have investigated the relevance of cognitive training to real-life tasks, and have studied parent/offspring and sibling similarity in adult cognitive performance. The dialectic process between data collection and model building that has been characteristic of my work has both increased our knowledge base and led to a number of methodological advances in the design and analysis of studies of human development and aging.

Over the course of my research career I have focused on five major questions, which I have attempted to ask with greater clarity and increasingly more sophisticated methodology as time progressed. These questions are the following:

1. What is the differential life course of intellectual abilities? Our work has shown that there is no uniform pattern of age-related changes across all intellectual abilities. Hence, studies using an overall index of intellectual ability (IQ) are of only limited usefulness for an understanding of age changes and age differences in intellectual functioning in individuals or in groups.

2. At what age can we observe a reliable decline in intellectual abilities and how large is the decline? Our general finding has been that reliable average decline in mental abilities does not occur before age 60 but that reliable average decline may be found for all abilities by age 74. Detailed analyses of individual differences in intellectual change demonstrated that even at age 81 fewer than half of all observed individuals experienced reliable decline over the preceding seven years. These findings provide a normative base that can help determine at what ages declines reach practically significant levels of importance for public policy related to issues such as ages for retirement eligibility, age discrimination in employment, or the determination of the population proportions that can live independently in the community.

3. How do successive generations differ in intellectual performance? The prevalence of substantial generational (cohort) differences in psychometric abilities has been conclusively demonstrated. When cross-sectional data are used as a first estimate of age changes within individuals, they tend to overestimate age

changes before the 60s for those abilities that show negative cohort gradients and underestimate age changes for those abilities with positive cohort gradients.

4. What are the causes of individual differences in age-related ability change in adulthood? The most unique contribution of a longitudinal program of research on adult development stems from the fact that one can investigate individual differences in antecedent variables that lead to early decline for some persons and maintenance of high levels of functioning for others well into very advanced age. Variables that we have identified as being important in reducing the risk of cognitive decline include (a) the absence of cardiovascular and other chronic diseases; (b) a favorable environment that is often a consequence of high socioeconomic status; (c) involvement in a complex and intellectually stimulating environment; (d) flexible personality style at midlife; (e) marrying an intelligent spouse; and (f) maintaining high levels of perceptual processing speed.

5. Can age-related intellectual decline be reversed through educational intervention?

Findings from our cognitive training studies suggest that intellectual decline observed in many community-dwelling older people is likely to be a function of disuse and is therefore reversible for many persons.

What Lies Ahead?

Life as a professional gerontologist encourages one to believe that scientific productivity can be maintained well into advanced old age. Consequently, because mandatory retirement for academics has ended, my future plans do not include formal professional retirement. Current work in my laboratory has just begun to examine the rate of intellectual aging in families and a seventh SLS cycle began in 1997, which includes a further follow-up on the effects of cognitive training and another set of longitudinal data waves. We have also begun to study the relationship between the psychometric measures of cognitive behavior and neuropsychological assessments to explore the possibility of earlier identification of risk for dementia, the relationship between cognitive change and prevalence of the high-risk allele of the Apo-E gene, and recruitment of participants who will allow us to conduct a postmortem to study directly anatomical and cellular features of the normal aging brain and their relations to cognitive behavior.

Longitudinal studies have a life of their own; they involve multiple generations of students and investigators. As all serious researchers know, there are no final answers or critical experiments. We continue to build on the work of those who came before us, and we hope our students will continue the quest. For those of us whose science also serves to help make meaning of our own lives, the study of gerontology is immensely rewarding; I could not have chosen a better or more intellectually exciting vehicle for my professional odyssey.

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The Course of Adult Intellectual Development

K. Warner Schaie

A program of research is summarized that represents the author's lifelong efforts to understand the adult life course of intellectual abilities. The Seattle Longitudinal Study has assessed mental abilities in more than 5,000 adults and has followed some for as long as 35 years. Integrative findings are provided on patterns and magnitudes of age changes, cohort differences, factor structure of mental abilities, antecedents for individual differences in aging trajectories, and interventions designed to remediate cognitive aging effects.

This article presents a relatively brief and integrative account of my lifelong efforts to gain an understanding of the basis for the vast individual variations in the life course of adult intellectual abilities. This work has been done within the context of the Seattle Longitudinal Study (SLS), which began as my doctoral dissertation at the University of Washington in 1956 and the sixth cycle of which was completed in 1992. The theoretical basis for my work on adult intellectual development was provided by Thurstone's (1938) conceptualization of psychometric intelligence. This influence was transmitted to me by my undergraduate mentor, Read Tuddenham, and one of my graduate teachers, Paul Horst. My graduate training in clinical psychology and the influence of my dissertation advisor, Charles Strother, are reflected in a continuing emphasis on the role of individual differences and the influence of sociocultural antecedents on ability functioning.

At an early stage of my career, I was confronted with addressing the discrepancies between cross-sectional and longitudinal findings in the study of adult

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Author's note; The kind of lifelong program of research summarized here must depend greatly on many contributions by colleagues and students too numerous to list. However, I wish to acknowledge my particular gratitude for the seminal contributions of my wife and colleague, Sherry L. Willis; to my mentors Read D. Tuddenham, Paul Horst, and Charles R. Strother, and to my colleagues and one-time students, Paul B. Baltes, Theresa M. Cooney, Ranjana Dutta, Kathy Gribbin, Ann Gruber-Baldini, Christopher Hertzog, Gisela Labouvie-Vief, Ann O'Hanlon, Scott B. Maitland, and Iris A. Parham. I am also greatly indebted for the enthusiastic support of members and staff of the Group Health Cooperative of Puget Sound. An earlier, limited portion of this overview, without the inclusion of our most recent data, appeared in Schaie (1993a). In addition to the cited research literature, extensive documentation of the data reviewed here will be found in a forthcoming monograph (Schaie, 1994).

This program of research has been supported since 1963 by various grants from the National Institute of Mental Health and the National Institute on Aging. It is currently supported by Research Grant R37 AG08055 from the National Institute on Aging.

intellectual development. I soon became convinced that this issue needed to be addressed by following over time a structured cross-sectional sample, such as the one I had collected for my dissertation. As a consequence, I designed a followup study that was put into the field in 1963 and provided some answers, but also raised sufficient methodological and substantive questions to demand a continuing program of research (including six major and several collateral data collections) that is still in progress.

Findings resulting from my previous efforts have been widely disseminated in the psychological and gerontological literature. A comprehensive report through Wave 4 of the study may be found in Schaie (1983). That report has been updated by various analyses of the Waves 5 and 6 data (e.g., Schaie, 1989a, 1990a, 1993a, 1993b; Schaie & Hertzog, 1986; Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992; Schaie et al., 1993; Schaie & Willis, 1993; Willis, 1989). I also refer the reader to a forthcoming monograph (Schaie, 1994), which provides more complete data on the entire set of studies. Anyone who studies behavioral change over age or time has to come to grips with understanding the relationship between cross-sectional and longitudinal data sets (the age-cohort-period problem). Thus, the course of this work has involved the dialectic interplay of substantive data collections that occasionally required the development of new methods or the reinterpretation of established methodologies (cf. Schaie, 1965, 1973, 1977, 1986, 1988). Here, I provide an integrative overview of both previously published work and the most recently acquired data for those less familiar with this work.

The Seattle Longitudinal Study

The principal data base for this study consists of more than 5,000 subjects, on whom cognitive and other collateral data were acquired during our six major testing cycles (1956, 1963, 1970, 1977, 1984, 1991; see Figure 1). In addition, there were four related studies dealing with the effects of life complexity, shifting our sampling procedures from sampling without replacement to sampling with replacement, the "aging" of the test battery, and cognitive similarity within biologically related persons (family study). All of our study participants are or were members of an HMO (Group Health Cooperative of Puget Sound) in the Seattle, Washington, metropolitan area, or family members of these individuals. This HMO has a large, individually recruited membership that includes independent crafts people, service occupations, and all levels of professionals; also, it serves as health care provider for governmental subdivisions and labor unions that include both blue-collar and white-collar employees. Although our sample underrepresents the lowest socioeconomic segment of the population, it is quite representative of at least the upper 75% range of the socioeconomic spectrum. This kind of broad population representation is rare in most studies of psychological individual difference variables.

Figure 1

Design of the Seattle Longitudinal Study

Study Waves					
1956	1963	1970	1977	1984	1991
S_1T_1	S_1T_2	S_1T_3	S_1T_4	S_1T_5	S_1T_6
(N=500)	(N=303)	(n=162)	(N=120)	(N=92)	(N=71)
	S_2T_2	S_2T_3	S_2T_4	S_2T_5	S_2T_6
	(N=997)	(N=420)	(N=337)	(N=204)	(N=161)
		S_3T_3	S_3T_4	S_3T_5	S_3T_6
		(N=705)	(N=340)	(N=225)	(N=175)
			S_4T_4	S_4T_5	S_4T_6
			(N=612)	(N=294)	(N=201)
				S_5T_5	S_5T_6
				(N=628)	(N=428)
					S_6T_6
					(N=690)

S = Sample; T = Time of Measurement

Similar to other longitudinal studies, we have encountered nonrandom dropout effects; that is, those who return for retest, on average, tend to outperform those who do not return. These dropout effects are of greater magnitude subsequent to the first retest occasion, and they are not systematically related to age. However, the reasons for dropout do change across the age span. Attrition effects have been reported for each of our study cycles, and we have proposed corrections that adjust for the effects of attrition and other confounds on estimates of cognitive age changes (e.g., Baltes, Schaie, & Nardi, 1971; Cooney, Schaie, & Willis, 1988; Schaie, 1988; Schaie, Labouvie, & Barrett, 1973).

The core battery used throughout our study has assessed the primary mental abilities of verbal meaning, space, reasoning, number, and word fluency, identified by Thurstone (1938) as accounting for the major share of individual differences in cognitive abilities in children and adolescents. Also assessed consistently have been the dimensions of rigidity-flexibility (Schaie, Dutta, & Willis, 1991; Schaie & Parham, 1975; Schaie & Willis, 1991).

Some limited demographic data were collected during the first three cycles. These have been supplemented since 1974 by a more complete personal data

inventory, the Life Complexity Inventory (LCI; Gribbin, Schaie, & Parham, 1980), that includes topics such as major work circumstances (with homemaking defined as a job), friends and social interactions, daily activities, travel experiences, physical environment, and lifelong educational pursuits. To be able to explore age changes and age differences in factor structure, we expanded the original core battery to include multiple markers for most abilities beginning with the fifth (1984) cycle. Additional markers were obtained from either the Educational Testing Service's kit of factor-reference tests (Ekstrom, French, Harman, & Derman, 1976), or from the Adult Development and Enrichment Project (ADEPT; Blieszner, Willis, & Baltes, 1981), or from specially constructed alternate forms (Schaie, 1985; Zelinski, Gilewski, & Schaie, 1993). The primary abilities of verbal comprehension, spatial orientation, inductive reasoning, numeric ability, and perceptual speed are now measured at the latent construct level (cf. Schaie et al., 1991; Schaie, Willis, Hertzog, & Schulenberg, 1987; Schaie, Willis, Jay, & Chipuer, 1989). Certain measures of verbal memory, a criterion measure of "real life tasks," the Basic Skills Assessment Test: Reading (Educational Testing Service, 1977), and a scale for measuring participants' subjective assessment of ability changes between test cycles (Schaie, Willis, & O'Hanlon, 1994) have also been added. Health history records were obtained for those subjects who were followed for at least 14 years. Each outpatient visit or hospital day was coded by diagnosis and annual illness counts were constructed by summing illness incidents and illness episodes (Gruber-Baldini, 1991; Hertzog, Schaie, & Gribbin, 1978).

Integrative Summary of Results From the Seattle Longitudinal Study

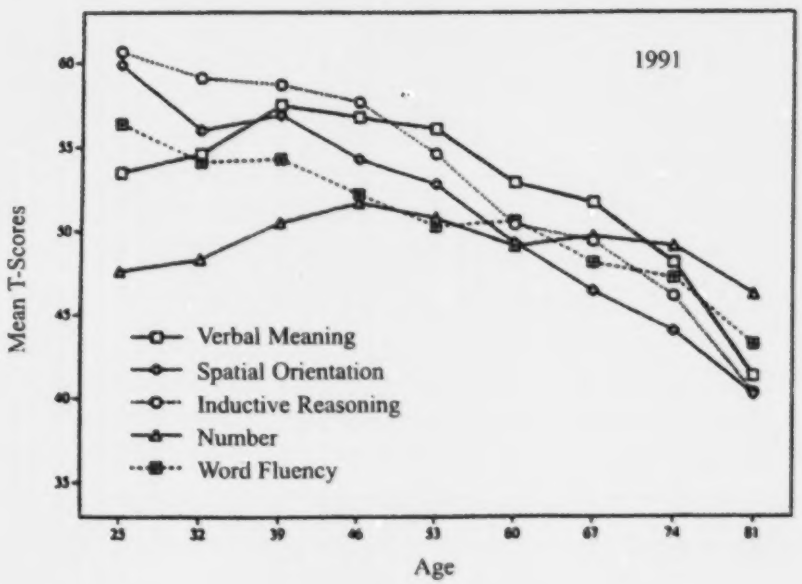
My inquiries have generally focused on six major questions, which I have attempted to ask with increasingly greater clarity and more sophisticated methodologies at each successive stage of the study (cf. Schaie, 1965, 1977, 1988). First, I wanted to know whether intelligence changes uniformly through adulthood or whether there were different life-course ability patterns. Second, it seemed important to discover at what age reliably detectable age decrements in ability occurred and to determine the magnitude of that decrement. Third, I was intrigued by the possibility of demographic shifts in intellectual performance; hence, I wished to investigate patterns of generational (cohort) differences in intellectual abilities as well as their magnitude. Fourth, I was concerned with the stability of the factor structure of the psychometric abilities across the adult life course. Fifth, I wished to determine what accounts for the vast individual differences in age-related change in adulthood. And, finally, influenced by the work of my wife and colleague, Sherry L. Willis, I questioned whether intellectual decline with increasing age can be reversed by educational interventions. I review these questions and try to provide an integrative report on what we have learned from the SLS to provide answers.

At the beginning of my inquiries, the then-scientific wisdom argued that psychological constructs should be measured with the best single marker for that construct. More recently, we have come to believe that it is better to measure inferred constructs by multiple markers. Given the length of these studies, I have more data on single than on multiple markers but will describe our findings at both levels.

Single ability markers. We have clearly shown that there is no uniform pattern of age-related changes in adulthood across all intellectual abilities. Hence, an overall index of intellectual ability (IQ) does not suffice if one wishes to understand age changes and age differences in intellectual functioning for either individuals or groups. This is the case whether age differences (cross-sectional data) or age changes (longitudinal data) are considered. To document this fact, Figure 2 shows cross-sectional patterns for the five abilities that have been examined throughout the entire study for the last (1991) study wave. The cross-sectional data simply involve a comparison of the directly observed standardized mean scores for all of the different seven-year age groups assessed during our last data collection. The cross-sectional data show two different patterns: (a) Three of the abilities peak in young adulthood and show linearly

Figure 2

Cross-Sectional Mean T Scores for Single Markers of the Primary Mental Abilities



Note: 1991 data.

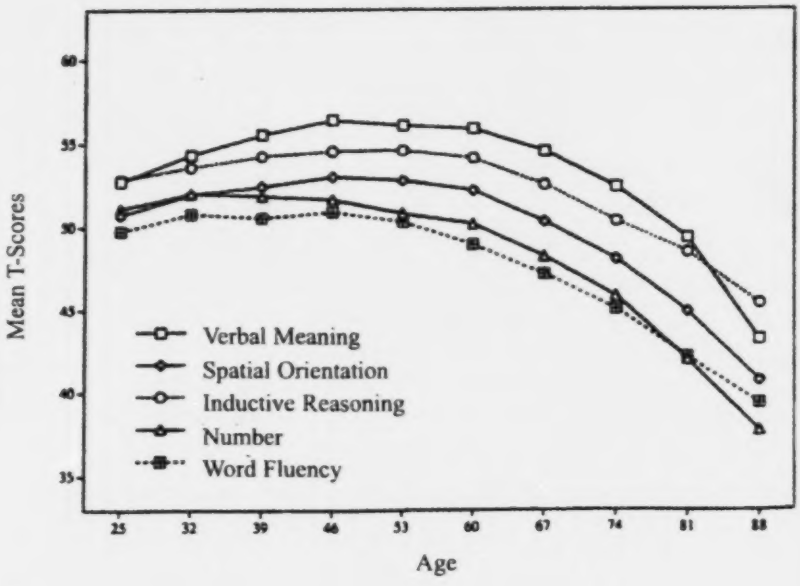
accelerating age differences that are steepest for spatial orientation and inductive reasoning, but are less pronounced for word fluency; and (b) verbal meaning and number peak in midlife. However, verbal meaning, a somewhat speeded test, begins to show negative age differences by early old age, whereas number has an almost level age-differences profile through adulthood.

Going beyond the between-group findings that confound age and differential experience, Figure 3 shows longitudinal gradients that were obtained by averaging, for each age segment, all of the within-subject data for those individuals who had been followed for the seven years bracketed by that age segment. In other words, each segment involves a longitudinal follow-up, but successive segments are on different individuals. Sufficient data were available to follow this procedure over the age range from mean age 25 to mean age 88. The seven-year age changes were then cumulated, and the longitudinal gradients were centered on the observed mean for the 53-year-old group (our average subject age) in 1991.

The longitudinal gradients show at least modest gain for all abilities from young adulthood to early middle age. But there remain differences among abilities with respect to the attainment of peak age as well as the degree to which age changes accelerate with advancing age. There are, moreover, important Ability x Gender, Ability x Cohort, and Ability x Age interactions that compli-

Figure 3

Longitudinal Estimates of Mean T Scores for Single Markers of the Primary Mental Abilities



Note: From 7-year within-subject data.

cate matters. We have noted systematic gender differences that favor women with respect to verbal meaning and inductive reasoning and favor men with respect to spatial orientation and number. In the more recent cross-sectional sequences, gender difference trends have emerged that suggest that women may decline earlier on fluid abilities, whereas men do so on the crystallized abilities. Although fluid abilities begin to decline earlier, crystallized abilities show steeper decrement once the late 70s are reached (cf. Schaie, 1983, 1990a; Schaie & Hertzog, 1983, 1986).

Cohort-related differences in the rate and magnitude of age changes in intelligence remained fairly linear for cohorts entering old age during the first three cycles in our study (until 1970); they have since shown substantial shifts. For example, rates of decremental age change have abated, while the earlier positive cohort trends have flattened as we begin to study members of the baby-boom generation. Patterns of socialization unique to a given sex role within a specific historical period may also be major determinants for the pattern of change in abilities. More fine-grained analyses, for example, suggest substantial gender differences when age changes are broken down into that proportions of change associated with either accuracy or speed (cf. Willis & Schaie, 1988).

Findings for measures of latent ability constructs. Realizing that single markers of an ability construct may limit the generalizability of developmental findings, we have added additional markers for each of six ability dimensions (inductive reasoning, spatial orientation, perceptual speed, numeric ability, verbal ability, and verbal memory), so that we can also report age difference and age change data at the latent construct level. For this purpose, the markers for a particular factor were weighted proportionally to their regression on the latest construct for the entire 1984 sample (cf Schaie et al., 1991; see Figure 4 for a list of the individual marker variables and the measurement model linking the observed variables to the latent constructs). Factor scores were then computed for the six ability dimensions for the data collected in 1984 and 1991.

The cross-sectional patterns for the latent ability factor scores for our last test occasion (1991) have been plotted in Figure 5. This figure shows that there are virtually linear negative age differences from young adulthood to old age for four latent abilities: inductive reasoning, spatial orientation, perceptual speed, and verbal memory. However, numeric and verbal abilities show a far more concave pattern. Numeric ability does not reach an asymptote until the mid-40s, significantly lower performance is reached by age 60, but then another, lower plateau is attained. Verbal ability reaches an asymptotic plateau from middle adulthood (39 years) to early old age (67 years), with only modest age differences thereafter.

Next, I present longitudinal data at the construct level. These data (graphed in Figure 6) again represent the within-cohort estimates of seven-year changes, centered at the observed mean value for age 53, to be compared with the cross-sectional data. For the longitudinal data, a pattern of linear age-related

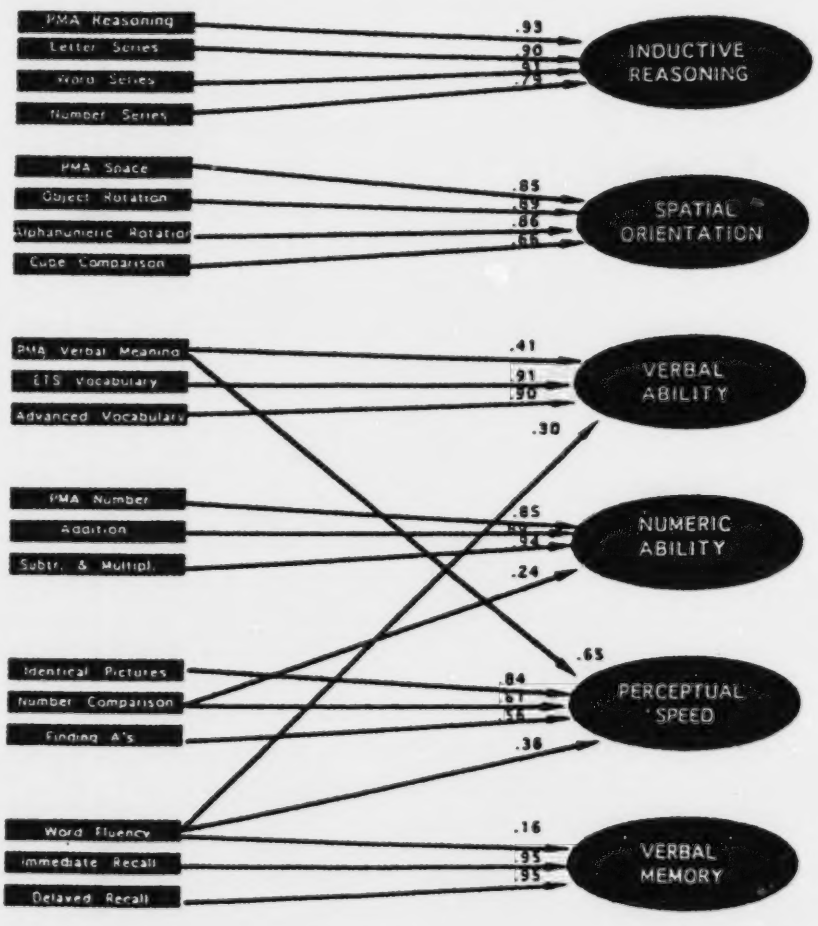
decline for young adulthood appears plausible only for perceptual speed (also see Schaie, 1989b). Numeric ability shows an early plateau with linear decline, beginning in the 60s. The other four abilities, however, reach an asymptote by age 53 and show only modest decline thereafter.

Age at Which Decrements Can Be Detected and Magnitudes of Age Decrement

The SLS findings provide a normative base that can serve as guidelines for the determination of the ages at which declines attain practically significant levels that may be relevant for public policy issues such as mandatory retirement,

Figure 4

Measurement Model Linking the Observed Variables and Latent Ability Constructs



Note: Data from Schaie, Dutta, & Willis, 1991.

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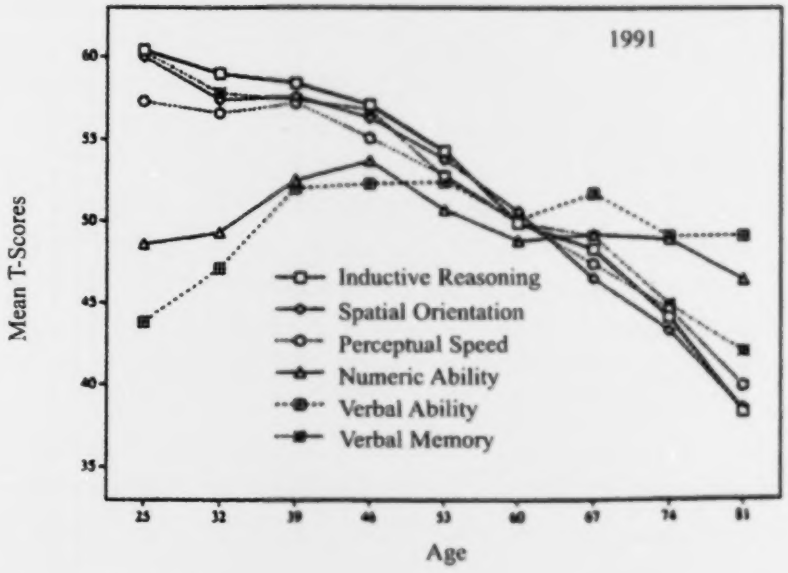
Figure 5

Cross-Sectional Mean Factor Scores for the Latent Ability Constructs



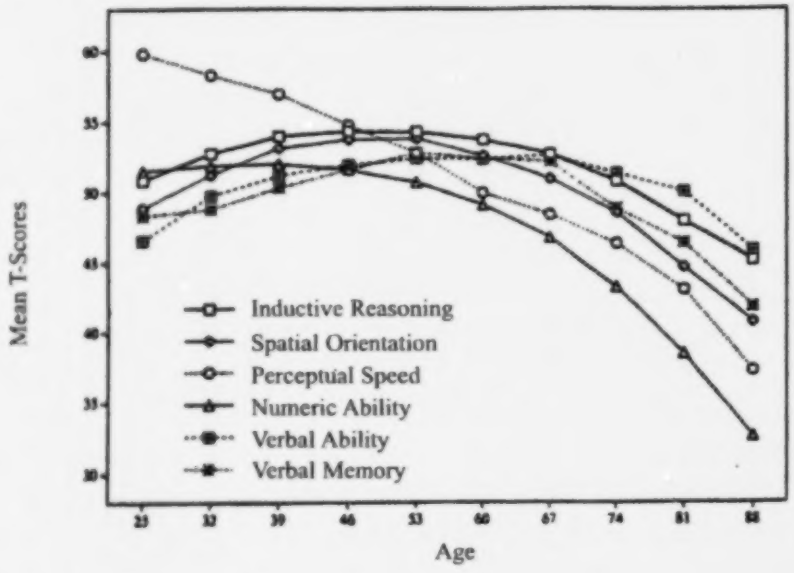
Note. 1991 data.

age discrimination in employment, or in determining what proportion of the population can likely be expected to live independently in the community. I have had ample opportunity to present my findings for such purposes in legislative hearings, in rule-making processes, and as an expert in age-discrimination litigation. Furthermore, although our primary variables may be conceived as being primarily laboratory tasks, the relevance of these findings to everyday behavior has been established by demonstrating substantial relationships between the psychometric abilities and real-life tasks (Willis & Schaie, 1986a).

The longitudinal data for the single markers collected over the past 35 years indicate that average age decrements in psychometric abilities cannot be reliably confirmed prior to age 60, except for word fluency, which shows significant decline by age 53. However, reliable average decrement is indeed found for all abilities by age 67 (Schaie, 1990b; Schaie & Hertzog, 1983). This decrement is modest until the 80s are reached, and for most individuals, it is not a linear phenomenon but occurs in a stair-step fashion (Schaie 1989b). Even at age 81, fewer than one half of all observed individuals showed reliable decrements over the preceding seven years (Schaie, 1984). Average decrement before age 60 amounts to less than 0.2 SD, but by age 81, average decrement increases to approximately one standard deviation for most abilities (Schaie, 1983, 1984). At the latent construct level, there are modestly positive age changes from young

Figure 6

Longitudinal Estimates of Mean Factor Scores for the Latent Ability Constructs



Note. From 7-year within-subject data.

adulthood to age 60 for inductive reasoning, spatial orientation, verbal ability, and verbal memory, but numeric skill declines by about 0.25 SD and perceptual speed slows by a full standard deviation. As compared with age 25, at age 88 there is virtually no decline in verbal ability; however, inductive reasoning and verbal memory have declined by better than 0.5 SD, spatial orientation by almost 1 SD, and numeric ability and perceptual speed have declined by more than 1.5 SD. Much of the late life decline, however, must be attributed to slowing of processing and response speed. When age changes in perceptual speed are removed from the other abilities, their magnitude of age decrement is significantly reduced (e.g., Schaie, 1989c).

Patterns and Magnitude of Generational Differences

Results from the SLS have conclusively demonstrated the prevalence of substantial generational (cohort) differences in psychometric abilities (Schaie, 1983, 1990b; Schaie & Hertzog, 1986; Willis, 1989). The cohort trends differ in magnitude and direction by ability and cannot therefore be determined from composite IQ indices. Cohort gradients for our single ability markers are shown in Figure 7, and in Figure 8 for the latent constructs (factor scores). These cohort gradients are obtained by differencing successive cohorts observed at the same

age. For the single markers, these estimates are based on cohort differences at up to five different age levels. For the latent constructs, only one common age level was available for each cohort pair.

With respect to the single markers, almost linear positive cohort shifts were observed for inductive reasoning and verbal meaning, with a more spasmodic positive shift for spatial orientation. These cohort differences are substantial and account for differences of more than 1 SD between the earliest and latest cohorts. On the other hand, response on our measure of number skill peaked with the 1924 birth cohort and declined progressively thereafter by about 0.5 SD. More recently born cohorts are also at a disadvantage when compared with prior cohorts on the variable of word fluency (Schaie, 1990b). From these findings, we concluded that cross-sectional studies used to model age change overestimate age-related decline prior to the 60s for those variables that show negative cohort gradients and underestimate such declines for the variables with positive cohort gradients. These conclusions are supported further by an examination of the cohort gradients for the factor scores. Virtually linear positive gradients across birth cohorts from 1907 to 1966 were found for inductive reasoning and verbal memory, amounting to a cohort difference of about 1.5 SD from the earliest to the latest cohort. Spatial orientation also showed a positive cohort gradient, but of a somewhat smaller magnitude. By contrast, we find concave cohort gradients for perceptual speed, numeric ability, and verbal ability. For

Figure 7

Cohort Gradients for the Single Markers of the Primary Mental Abilities

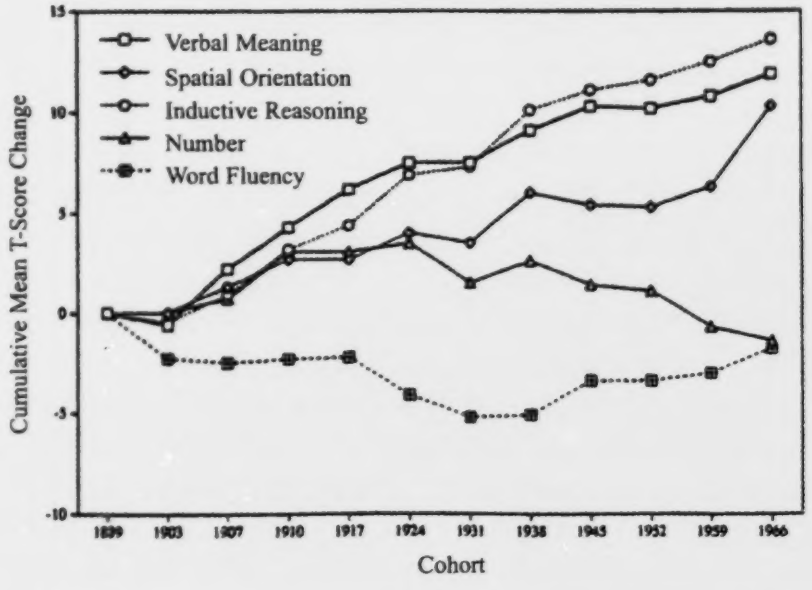
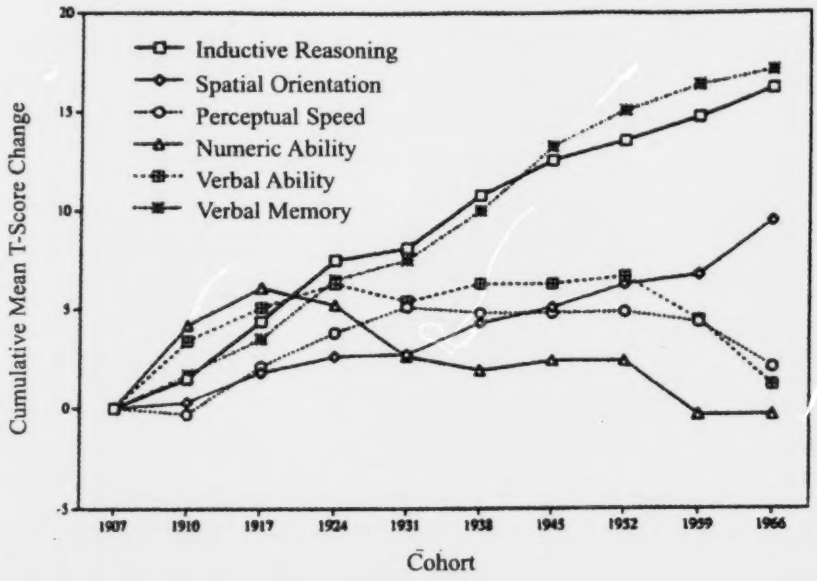


Figure 8

Cohort Gradients for the Latent Ability Constructs



these latter abilities, there seems to be a positive gradient for cohorts born in the first quarter of the century, a plateau for the depression cohort.

A number of factors have been implicated for these dramatic cohort differences. Increased level of formal education appears to be the most explanatory factor for those abilities showing increments for successive cohorts. For those abilities showing a curvilinear pattern, shifts in educational strategies and intensity of exposure to relevant materials may be most the most important antecedents of cohort differences.

To supplement the work on generational differences in abilities among unrelated individuals, we have recently studied family-\ members of our longitudinal study participants (Schaie et al., 1992, 1993). Most work in developmental behavior genetics has been conducted by means of twin studies. It has only recently been recognized that because of the unique characteristics of twins, broad generalizations from such studies will be limited and corroborative data are needed from family studies of parent-offspring and nontwin siblings. In the past, such studies used parents and their young offspring and young sibs; our study is the first effort to explore systematic family similarity through adulthood as well as to test for stability of such similarity over time.

An average family similarity of about .25 was observed for virtually all mental abilities and our measures of flexibility. Similarities were found for both parents and their offspring (adult children) and for siblings (brothers and sisters). The two exceptions to this finding were for the attitudinal measure of social

responsibility (Schaie & Parham, 1974) and for a measure of perceptual speed, neither of which seem to display heritable characteristics. The magnitude of parent-offspring and sibling similarity differed for specific abilities, and the overall similarity was somewhat greater for parent-offspring pairs. The size of the correlations were also comparable with those found between young adults and their children in other studies (e.g., Defries et al., 1976). Because of changes in our society, it has been argued that there ought to be a reduction in family similarity for younger as compared with older parent-offspring pairs. The possible reduction in shared environmental influence is thought to be due to increased outside influences in the more recent generation. However, this proposition could be supported only for inductive reasoning, wherein the old and middle generations showed somewhat greater similarity than the younger generation. For other abilities, we found stability, and for some abilities (verbal meaning and spatial orientation), even an increase in family similarity for more recent generations. Correlating relative performance with the longitudinal target subjects over 7, 14, and 21 years of age, moreover, provided strong evidence for stability of family similarity over time and age.

Stability of Psychometric Ability Structure

Ever since the early factorial studies of age differences in the factor structure of the Wechsler Adult Intelligence Scale (WAIS; Cohen, 1957), we have been aware of the fact that there is a distinct possibility that a particular observed marker variable may not retain the same relationship to the underlying latent construct that it is presumed to measure. Such shifts in the regression of observed variables on the latent construct, if found, would impose significant restrictions on the interpretability of age changes and age differences measured with single markers. As soon as we had collected multiple marker data, we proceeded with cross-sectional factor analyses of the invariance of ability structure over the entire age range included in our study. Most recently, we have also conducted longitudinal factor analysis over the seven-year interval for which multiple marker data are available.

The most stringent definition of factorial invariance would require that the factor loadings, factor variances, and factor covariances can be constrained equally across all comparison groups (complete metric invariance). A somewhat less stringent criterion that is more reasonable when applied to developmental studies is to allow differences in the factor variances and covariances but retain the requirement for equality of the factor loadings across comparison groups (semimetric invariance). In the recent literature on factorial invariance, an even less stringent criterion is suggested to demonstrate factorial invariance. This latter criterion requires only that the same number of factors and the same factor patterns prevail, so that across comparison groups the same tests load signifi-

cantly on their hypothesized factor and can be set to zero for all other factors (configural invariance; also see Horn, 1991; Horn, McArdle, & Mason, 1983).

In the cross-sectional comparisons, we were able to demonstrate configural invariance (maintenance of factor pattern) but not metric factor invariance (invariance of the pattern coefficients) across a wide age-cohort range (ages 29 to 81). Differences in the regression weights assigned to the individual marker variables, however, were minor for the age range from 39 to 77 years. They were not inconsequential, however, for both the youngest and oldest groups studied (Schaie et al., 1989).

In the longitudinal factor analyses, we first tested the fit of the entire sample of subjects tested in both 1984 and 1991. In this analysis, we were able to demonstrate semimetric invariance of factor structure over seven years. That is, allowing the factor variances and covariances to vary over time, we obtained significant improvement of model fit. However, no such improvement was obtained when we freed the constraints across time on the factor loadings, indicating that there was no significant change over time in the regression of the observables upon the latent factors. We then tested the fit to the common model (see Figure 4) for six subsamples that were observed from mean ages 32 to 39, 46 to 53, 53 to 60, 60 to 67, 67 to 74, and 76 to 83, respectively. As we expected from the earlier cross-sectional analyses, we can accept invariance of factor patterns but not of the regression coefficients across groups. Within groups, once again, we obtain improvement in model fit if we allow the factor variances and covariances to vary over time, but we can accept the stability of the regression weights across time in the individual groups as well (semimetric invariance). These findings strongly suggest greater stability of individual differences within cohorts than across cohorts, and provide another argument for the superiority of longitudinal data.

Antecedents of Individual Differences in Age-Related Change

The unique contribution of a longitudinal study such as the one described here is the investigation of individual differences in antecedent variables that lead to early decrement for some persons and maintenance of high levels of functioning for others, well into very advanced age. We have implicated a number of factors that account for these individual differences, some of which have been shown to be amenable to experimental intervention. In each case, we tested and rejected reciprocal causal models. The variables identified to reduce the risk of cognitive decline in old age include the following:

1. The absence of cardiovascular and other chronic diseases. We do not claim a direct causal linkage, rather we suspect that the same behaviors that lead to the early onset of chronic diseases also reflect lifestyles that are unfavorable for the maintenance of high levels of cognitive functioning (Gruber-Baldini, 1991; Hertzog et al., 1978).

2. Living in favorable environmental circumstances as would be the case for those persons characterized by high SES. These circumstances include above-average education, histories of occupational pursuits that involve high complexity and low routine, above-average income, and the maintenance of intact families (Gribbin et al., 1980; Schaie, 1984).

3. Substantial involvement in activities typically available in complex and intellectually stimulating environments. Such activities include extensive reading habits, travel, attendance at cultural events, pursuit of continuing education activities, and participation in clubs and professional associations (Gribbin et al., 1980; Schaie, 1984).

4. Individual's self-report of a flexible personality style at midlife as well as flexible performance on objective measures of motor-cognitive perseveration tasks (Schaie, 1984).

5. Being married to a spouse with high cognitive status. Our studies of cognitive similarity in married couples suggest that the lower functioning spouse at the beginning of marriage tends to maintain or increase his or her level vis à vis the higher functioning spouse (Gruber & Schaie, 1986).

6. The maintenance of high levels of perceptual processing speed into old age (Schaie, 1989c). As indicated earlier, aging effects on other cognitive abilities tend to be confounded with the perceptual and response speed required to process the tasks used to measure these abilities. Thus, individuals who remain at high levels of perceptual speed are also at advantage with respect to the maintenance of other abilities.

7. Rating one's self as being satisfied with one's life's accomplishment in midlife or early old age. Such individuals seem to be at advantage when assessed at a later age.

An attempt has also been made to apply event history methods to develop life tables for the occurrence of decline events on the five single-ability markers and to develop a calculus that allows estimation of the most probable age at which an individual can expect to experience decline on each of these abilities (Schaie, 1989a). The most highly weighted variables in this calculus that predict earlier-than-average decline are significant decrease in flexibility during the past seven-year period, low educational level, male gender membership, and low satisfaction with life success.

Reversing Intellectual Decline by Educational Interventions

Because longitudinal studies permit tracking individual levels over time, Sherry Willis and I were able to design interventions that have remediated known intellectual decline and have also reduced cohort differences in those individuals who remained stable in their own performance over time but who became disadvantaged when compared with younger persons. Because fluid abilities tend to decline earlier and are thought to be more resistant to education-

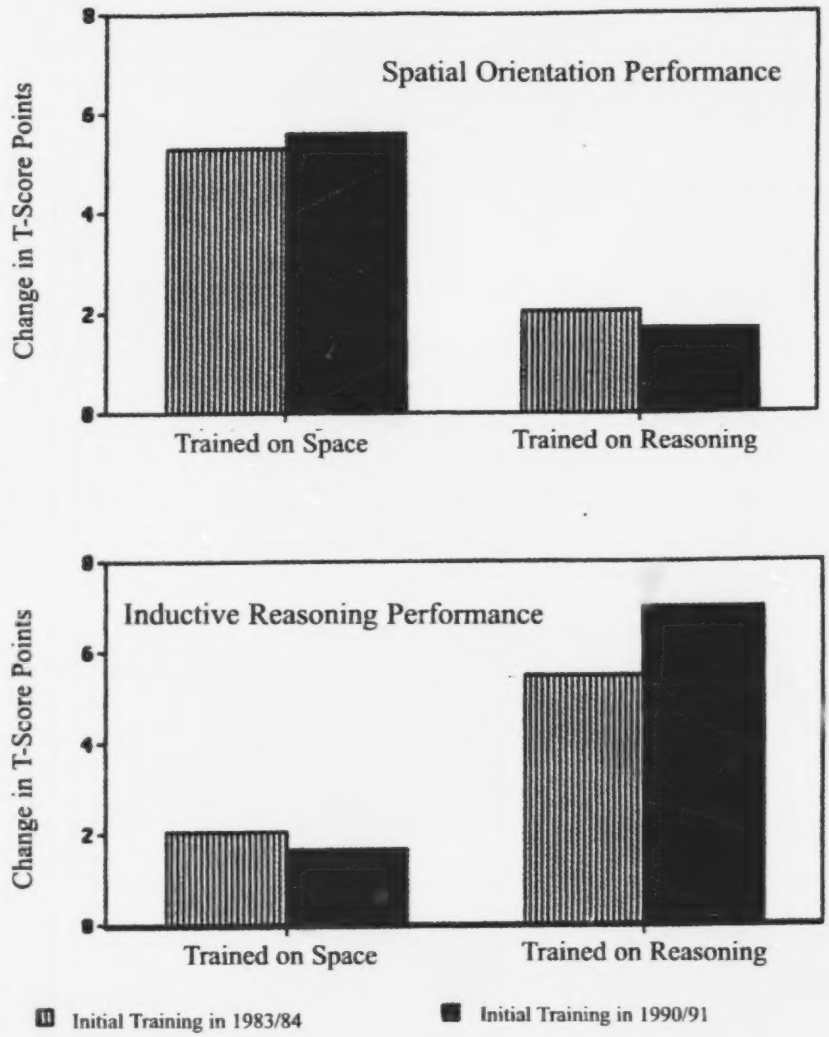
al intervention, we proceeded to design interventions specific to the abilities of inductive reasoning and spatial orientation. Dr. Willis conducted task analyses of our assessment battery for these abilities and then developed training material sufficient to provide five one-hour sessions of individual strategy training. We selected subsamples of individuals who were 65 years of age or older in 1983 and did so again in 1991. Subjects were classified, using a 1 SEM confidence interval about base performance criterion, as to whether they had declined over the previous 14 years on one or both of the abilities of interest. If they had declined on only one ability, they were assigned for training with respect to that ability. If they had declined on both abilities or had remained stable on both abilities, they were assigned to the two training conditions at random. All of the participants of the training study received the full cognitive battery twice in a pretest-training-posttest design, with each training group serving as the control for the other training condition.

In the initial training study, conducted in 1983-1984, we trained 228 subjects. Approximately two thirds of our experimental subjects showed significant improvement, and about 40% of those who had declined significantly over the prior 14 years were returned to their pre-decline level (Schaie & Willis, 1986). An additional 179 subjects (not previously trained and selected to match the sample in the first study) were initially trained in 1990-1991. As suggested earlier, those subjects who remain in the study for at least 14 years have somewhat more favorable demographic characteristics and base ability levels than those not available because of attrition (cf. Schaie, 1988). However, they are quite comparable at base levels across training groups, and cohort differences between the 1983 and 1990 samples are similar to those observed for the entire data set.

Figure 9 shows the magnitude of training gain from pre- to posttest for the original study and for the replication. Training effects amounted to approximately 0.5 SD. Training was somewhat more effective for inductive reasoning than for spatial orientation. There was also a trend for men to benefit more from inductive reasoning training, whereas women benefited more from spatial orientation training (to the extent of removing the reliably demonstrated gender difference for that ability subsequent to training). Training was also somewhat more effective for those individuals who declined prior to the intervention. We were also able to show that we did not simply train to the test, but rather trained at the ability (latent construct) level (Willis & Schaie. 1986b), and that the training did not disturb the ability structure described earlier (Schaie et al., 1987), thus providing evidence that training results in quantitative change on the targeted constructs without any accompanying qualitative shifts in the skills that were trained. Training gains seem to represent largely increased accuracy for men, but a mix of improvement in accuracy and speed for women (Willis & Schaie, 1988).

Figure 9

Magnitude of Training Effects From Pre- to Posttest



In our recent follow-up of the initial training, we were able to reassess 141 subjects after an average interval of seven years. These individuals were then given additional booster training for the same ability on which they had been trained initially. We were able to show that persons trained remain, on average, at a significant advantage over their controls even after seven years. The advantage resulting from the initial training, furthermore, could be substantially increased by a five-hour course of booster training.

Although these interventions were conducted with specific laboratory tasks, their relevance to the subjects' ability to cope with the demands of daily living has been supported by showing substantial correlations between the psychomet-

ric abilities that we trained with measures of practical intelligence (Willis & Schaie, 1986a) and with objective measures of performance on instrumental tasks of daily living (Willis, Jay, Diehl, & Marsiske, 1992). The results of the cognitive training studies conducted with our longitudinal subjects suggest that observed ability declines in many community-dwelling older people are probably due to disuse and are consequently reversible, at least in part, for many persons.

Summary

The Seattle Longitudinal Study has charted the course of selected psychometric abilities from young adulthood through old age and has investigated individual differences and differential patterns of change. Our concern has not been limited to demonstrating the presence or absence of age-related changes and differences; we have also provided data on the magnitude and relative importance of the life-course changes that we have studied over the past 35 years. In addition, we were able to identify some of the contextual, health, and personality variables that offer explanations for differential change over time, knowledge of which provide a conceptual basis for possible interventions. We have also demonstrated the invariance of psychometric ability structures within groups over time and, at a less rigorous level, across groups. Within the context of the SLS, we have studied cognitive similarity within parent-offspring and sibling pairs. Finally, we have designed cognitive interventions that have been successful in remediating carefully determined declines and in improving the cognitive functions of older persons who have remained stable.

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The Impact of Longitudinal Studies on Understanding Development from Young Adulthood to Old Age

K. Warner Schaie

This essay considers progress in understanding adult development in the study of behavior during the 20th century. It describes the influence of methodological advances including paradigmatic shifts from cross-sectional to longitudinal studies, advances in measurement, the impact of confirmatory factor analysis, and consideration of age as the dependent variable. A theoretical framework for understanding adult cognitive development is presented. Different types of longitudinal studies, the issue of structural invariance across age, sources of individual differences and the impact of cohort differences are discussed. Finally projections are made for future research.

The purpose of this essay is to consider how our understanding of adult development in the study of behavior has progressed over the course of the 20th century. When I agreed to undertake this task I began to think on how my own views of adult development had developed over the past 50 years, and I therefore tried to identify those critical factors that contributed to my current understanding of the influences that affect adult development. It became clear to me very quickly that these conceptions had largely been shaped by being engaged throughout my career in the pursuit of a set of large-scale longitudinal studies. These studies were designed to systematically identify the influences that differentiate between the lucky individuals who age successfully (cf. Rowe & Kahn, 1987) and those who are exposed to a variety of hazards likely to lead to early decline and low levels of functioning in the final part of their lives (cf. Schaie, 1989, 1996b,c). This thinking led me to organize the essay largely in terms of what we have learned from longitudinal studies, primarily those of cognition and personality.

Over the course of the 20th century many relevant lessons learned from the social and biological sciences have required behavioral sciences to become less parochial and more comfortable in considering the convergence of scientific findings from adjacent disciplines. To commence this somewhat personal account of the recent history of the developmental psychology of aging I will therefore provide a theoretical framework that represents my recognition (and all that I have learned from colleagues in interdisciplinary settings) that behavioral change can only be understood (and predicted for that matter) by examining behavioral change in the context of societal change (cf. Riley, Foner, & Riley, 1999). The model also gives due recognition to lasting heritable influ-

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ences (cf. Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992), as well as to the obvious age-related changes in the efficiency of the physiological infrastructure (Cristofalo, Tresini, Francis, & Volker, 1999).

The First Half of the 20th Century

The field of adult development and aging developed quite slowly during the first half of the 20th century. A comprehensive overview of early gerontology can be found in Cowdry's *Problems of Aging* (1939). This volume was quite light on psychological content and even Birren's monumental *Handbook of Aging and the Individual* published in 1959, still confined psychological aging to no more than about half of this single volume account.

An early seminal influence for the psychology of aging was a quasi-autobiographical account of the last part of his life by one of the founders of American developmental psychology, G. Stanley Hall (1922). But attention to the psychological development of adults was also fostered by the need of the military during World War I to classify and assign large numbers of young and middle-aged draftees to emerging specialty roles. This need led to an extension of the mental testing movement begun by the work of Binet and Simon (1905) with children, to the construction of tests suitable for adults (Yerkes, 1921). The availability of assessment instruments such as the Army Alpha test led to an interest in age-comparative studies (e.g., Jones & Conrad, 1933; Miles, 1931). Emergence of the field of clinical psychology incurred further development of tests specifically tailored for work with adults (Wechsler, 1939) and continued the interest in studying adult age differences. An active research program on human aging was begun under the direction of Nathan Shock at the National Institutes of Health with psychological research being initiated by James Birren in 1947. About the same time, the Nuffield Unit for Research on Aging was established at the University of Cambridge (Welford, 1951). Research on aging also began during the 1950s at the University of Bonn in Germany (Schmitz-Scherzer & Thomae, 1983). The Division on Adult Development and Aging of the American Psychological Association was founded in 1945. But formal recognition of aging as a major research field probably occurred only when the National Institute on Aging was established in 1975.

Because I intend to limit my essay to the influence of longitudinal work on understanding adult development, I will deal primarily with work that occurred in the second half of the 20th century. More detailed accounts of the psychological aspects of adult development during the first half of the 20th century can be found in Birren (1961), Birren & Birren (1990), Birren & Schroots (1994), Jones (1959), and Riegel (1977).

The Influence of Methodological Advances

I would be remiss if I were not to call attention to the influence of methodological advances in shaping our understanding of adult development (cf. Schaie, 1988, 1992). These advances have resulted in several paradigmatic shifts that have markedly changed the face of research on adult developments. The advances I will discuss here include first the shift from the dominance of cross-sectional data collections to the recognition of the importance of longitudinal designs. Second, there have been significant advances in the measurement of change, so essential to studies of development and aging. Third, there has been a change from data-driven exploratory factor analysis to hypothesis-testing confirmatory factor analysis that has been particularly relevant to the study of developmental phenomena. Fourth, there has been a conceptual shift of treating age as the dependent rather than the independent variable, and finally there have been increasing efforts to study development by means of growth curves.

The paradigmatic shift from cross-sectional studies of age differences in the study of human development to longitudinal ones was extremely important. This shift, of course, included the understanding of the fact that the elicitation of antecedent-consequent relationships in the study of development clearly requires following the same individuals over time (Mason, Mason, Winsborough, & Poole, 1973; Ryder, 1965; Schaie, 1965, 1977). This understanding was precipitated to some extent by the follow-up of members of longitudinal studies that began in early childhood or late adolescence when they reached early adulthood or middle age (e.g., The Berkeley Growth and Guidance studies, Barley & Oden, 1955; Eichorn, Clausen, Haan, Honzik, & Mussen, 1981; or the Iowa State ROTC follow-up studies, Owens, 1953, 1966). Failure to replicate the decline in function from young adulthood into middle age inferred from cross-sectional data (e.g., Jones & Conrad, 1933) necessitated coming to grips with the contrasting inferences to be drawn from cross-sectional and longitudinal data.

The second methodological advance that resulted in a major impact on the study of adult development actually occurred in the field of measurement; specifically following some heated debates and increasing sophistication in the understanding of the measurement of change. This debate began early on with the recognition that measurement imperfections (i.e., deviations of observed scores from true scores) were likely to cumulate in gain (or loss) scores comparing multiple measurements of the same individuals (Thorndike, 1924). This issue was further developed by Lord (1956), and the debate became more heated in the 1960s when many developmentalists despaired at being able to assess change adequately (cf Cronbach & Furby, 1970; Harris, 1963). Since studies of adult development require the test of hypotheses about directional changes, difference scores have always played an important role. Fortunately, it was soon recognized that a major problem occurs in two-point studies, leading to the

advocation of multiple occasion studies (Nesselroade, Stigler, & Baltes, 1980; Rogosa, Brandt, & Zimowsky, 1982; Willett, 1989) and of growth curve modeling (see later).

A third paradigmatic shift was facilitated by the introduction of formal methods of confirmatory factor analysis and structural equations modeling. Earlier methods of exploratory factor analysis have always been utilized in studies of adult development to determine latent constructs from observed variables. But even more important has been the use of factor analysis for the purpose of determining whether psychological constructs change across samples of different ages or within the same samples over time (cf. Reinert, 1970). Early approaches to the study of multiple groups can be found in the writings of Thurstone (1947), Guttman (1952), and in work in the Cattell laboratory (e.g., Cattell & Cattell, 1955). However, it was not until the advent of high speed computers that algorithms could be developed that were applicable to more than a minimal number of variables (Jöreskog, 1971; Sorbom & Jöreskog, 1978). Confirmatory factor analysis makes it possible to assess systematically the invariance (stability) of the regression of the latent constructs, which are of primary interest to science, upon the observed variables. In studies of adult development, such invariance is a singular prerequisite for the comparison of individuals and groups over long periods of time, or the comparison of groups of different individuals who differ in salient characteristics. Confirmatory factor analysis, for example, can be used to test hypotheses about the differentiation and dedifferentiation of psychological domains across the adult lifespan (Baltes & Lindenberger, 1997; Reinert, 1970; Schaie, Maitland, Willis, & Intrieri, 1998).

A fourth important methodological development involved the paradigmatic shift of considering chronological age as a dependent rather than an independent variable. First introduced conceptually by Wohlwill (1973), behavioral scientists soon began to realize that the study of age or duration time as a dependent variable could be operationalized via methods of survival or event-time analysis (Allison, 1984; Schaie, 1989; Singer & Willett, 1991). This approach is important in both cognitive and health psychology, because the prediction of morbidity and mortality by means of earlier behavioral characteristics requires not only the definition of end-points but also the timing (respectively age) at which such end-points are most likely to occur (e.g., Bosworth, Schaie, Willis, & Siegler, 1999).

As longitudinal studies have been conducted for longer periods of time with multiple measurements, it is now possible to apply powerful methods of growth curve modeling (LGM) that allow separating patterns of individual change over time from the group averages that had previously represented the primary focus of inquiry. These methods also allow incorporating covariates and predictors of different forms of development. Multivariate growth curve methods were first introduced by Tucker (1958). Again, intensive development required the advent

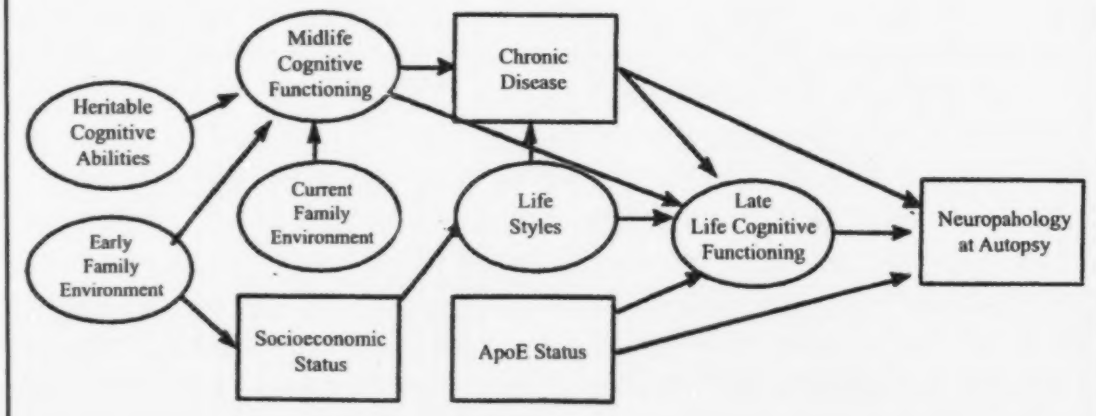
of more powerful computational resources, leading to modern methods of multilevel modeling (Bryk & Raudenbush, 1987; Rogosa & Willett, 1985; Rudinger & Rietz, in press; Willett & Sayer, 1994). LGM models are of particular interest in the study of adult development, because differences in genetic predisposition and environmental exposure may result in aging patterns that differ markedly for subsets of the population as well as for groups of individuals with either very favorable or unfavorable life experiences.

A Theoretical Framework for Understanding Adult Cognitive Development

An understanding of development from early adulthood to old age must include embedding what we know about development within the context of changing environmental influences and changes in individuals' physiological infrastructure. Figure 1 displays a schematic of how these influences might operate over the adult life course in the case of cognition. The schematic contains two end-points: first we are concerned with the lifelong influences that affect the level of late life cognitive functioning. But a secondary end-point is represented by the status of the cortex at life's end that would describe the infrastructure relevant to the maintenance of cognitive functioning that can only be determined post-mortem. In this conceptual path model, rectangles are used to identify those individual indicators that are observed directly, whereas ovals are used to indicate the latent constructs which would be inferred from measurement models for sets of observed variables.

Figure 1

A Conceptual Model for Influences Affecting Late Life Psychological Functioning in the Sample Case of Cognition



The astute reader will immediately argue that the arrows in Figure 1, other than those directed towards the end-points, that represent the interplay of the various causal influences may be too simplistic. Indeed, we could have posited several reciprocal relationships. However, I have tried to keep the model as simple as possible, because I intend to use it primarily for its heuristic value, rather than fitting the model to specific sets of data. However, I would like to indicate that all of the causal paths specified in the model were suggested by empirical investigations in my own laboratory or the work of other cognitive developmentalists.

Let me now try to explicate some of the attributes of the heuristic model. The initial bases for adult cognitive functioning must, of course, be attributed to both heritable (genetic) influences as well as early environmental influences typically experienced within the home of the biological parents. Although some of the behavior genetic literature suggests that much of the early environmental variance is nonshared (e.g., Plomin & Daniels, 1987), there is recent retrospective evidence that there may indeed be some early shared environmental influences on later cognitive performance (Schaie & Zuo, 2000). Both genetic and early environmental factors are thought to influence midlife cognitive functioning. The early environmental influences will, of course, also exert influences in midlife social status (Nguyen, 2000). By contrast, virtually no correlations have been found between retrospective accounts of family environment in the family of origin, and environment in the current family (Schaie & Willis, 1995). However, the current family environment does seem to influence midlife cognitive performance. Genetic factors are also likely to be implicated in the rate of cognitive decline in adulthood. Thus far the best-studied gene in this context is the Apo-E gene, one of whose alleles is thought to be a risk factor for Alzheimer's disease. Apo-E status is therefore added as a factor; the expression of the gene is probably not at issue prior to midlife.

We are now ready to specify the causal influences that determine level of cognitive function in late life as well as cortical status at autopsy. The direct influences to be implicated in addition to genes whose expression is turned on in late life most likely originate in midlife. They include level of cognitive functioning in midlife, midlife lifestyles, and the incidence and severity of chronic disease. But there are indirect influences attributable to the effects of midlife cognitive function and lifestyles on chronic disease, as well as shared family influences on midlife cognition and of social status on midlife lifestyles.

Although some of these paths represent concurrent observations that would allow alternative paths (respectively, reciprocal causal paths), most of the paths specified by the model represent antecedent-consequent relationships which require longitudinal data for their estimation and understanding. I will therefore now turn to what has been learned about adult cognitive development through longitudinal studies.

Longitudinal Studies of Adult Development

From the very beginning of empirical inquiry on development beyond adolescence substantive concerns were limited primarily to the areas of intellectual development and personality traits. Investigators interested in the age-related aspects of learning and memory largely adopted the paradigms popular in early experimental child psychology and thus limited themselves to age-comparative studies of young and old adults. Only recently have we seen an interest in this area in studies that would investigate the developmental mechanisms by use of longitudinal paradigms (see Salthouse, 1999).

Cross-sectional studies predominated until the late 1930s and clouded our understanding of adult development due to the confusion of age-related development with secular changes expressed as cohort effects. For example, successive studies of adult age differences in intelligence reported asymtotic peak performance to occur at ever later ages. Thus, Terman (1916) in his standardization of the Stanford-Binet thought that intelligence peaked at age 16, and Yerkes' (1921) estimate of World War I soldiers was even lower at age 13. By 1939, Wechsler's standardization sample peaked between 18 and 24 years, similar to the top ages found by Jones and Conrad (1933).

Types of Longitudinal Studies

The initial longitudinal studies that informed our understanding of adult development were of two types. First, there were studies that began with a focus on early childhood and child-rearing practices, but whose participants were followed into adulthood. A prime example of such a study is the follow-up of the Berkeley Growth and Guidance studies (Bayley & Oden, 1955; Eichorn et al., 1981). A second group of studies traced participants who had been assessed as young adults as part of their college experience and were reassessed in midlife or later. One example of such studies is Owens (1953, 1966) follow-up of persons in their fifties who had first been assessed as ROTC members during World War I.

Contrast Between Cross-Sectional and Longitudinal Studies

The earlier cross-sectional studies (e.g., Jones & Conrad, 1933) placed peak performance in intelligence and other positive psychological attributes in late adolescence or early young adulthood with linear decline occurring thereafter. By contrast, the longitudinal follow-up studies suggested that psychological growth continued generally into early midlife and for some variables (notably the verbal abilities) at least into the fifties. My own early work (Schaie, 1958) with cross-sectional data on mental abilities and rigidity-flexibility in adults over the age range from the twenties to the sixties suggested that, although peak

performance now occurred in the twenties and thirties, linear decline still prevailed thereafter. I vividly remember a conversation with Harold Jones in 1959 or so, trying to understand the differences between the cross-sectional and longitudinal findings. His suggestion was that we were dealing with noncomparable samples and different measurement variables as well as the attrition effects in longitudinal studies. These were all points well taken, but I felt that there was something more fundamental at stake.

The Seattle Longitudinal Study

I soon became convinced that the cross-sectional versus longitudinal issue needed to be confronted directly by following a structured cross-sectional sample over most of the adult lifespan. I therefore designed a study that converted my original cross-sectional study into a series of short-term longitudinal studies of mental abilities each extending over a simultaneous seven-year period (Schaie & Strother, 1968). My replicated cross-sectional findings were quite similar to the original findings, but the longitudinal data showed later ages of peak performance, maintenance of average functions on most abilities until the sixties, and only modest decline through the seventies. Further extensions of these studies (with some longitudinal data over as long as 42 years) over the past several decades have consistently replicated these findings, with dramatic declines not experienced until the eighties are reached (Schaie, 1983, 1996b; Schaie & Hertzog, 1986; Schaie & Lavouvie-Vief, 1974). I will come back to other matters learned from this study later on, but first must dwell a bit on other longitudinal approaches to the study of aging.

Lifespan Oriented Studies

The early work on adult development was pretty much oriented within the context of a lifespan development framework (cf. Baltes, 1987, 1997), but the burgeoning field of geropsychology soon divided into at least two rather different orientations. Some of us remained committed to the notion that an understanding of the aging process required the careful charting of human development at least across the entire adult lifespan, if not beginning our inquiries in childhood. This orientation, which I share, holds that what is of primary interest is the understanding of the mechanisms that contribute to the behavioral differences between youth and old age within a process that extends across the lifespan. Most of the studies mentioned earlier illustrate this type of approach.

Studies Originating in Late Life

The second orientation, sometimes labeled the "clinker method" (after the residue that remains when charcoal is produced), considers the characteristics of

the elderly to be of primary interest, and would investigate the aging process only from that period of life when a categorical transformation, such as leaving the world of work or family dissolution due to death of a spouse, has begun. Representative longitudinal studies of the second orientations therefore began at an advanced age. Several of these types of studies began during the 1960s and 1970s when the subjects were in their sixties.

Perhaps the most prominent of studies begun in late life has been the Duke Longitudinal Study (Palmore, Busse, Maddox, Nowlin, & Siegler, 1985). But many others can be found in the literature conducted in a variety of industrial societies (e.g., Canada: Hultsch, Hertzog, Dixon, & Small, 1998; Germany: Schmitz-Scherzer & Thomae, 1983; Rott, 1993; Israel: Shanan, 1993; Sweden: Svensson, Dehlin, Hagberg, & Samuelsson, 1993; United Kingdom: Rabbitt, 1993). Other more recent studies have focused on following those in very late life (e.g., Baltes & Mayer, 1999; Poon, Sweeney, Clayton, & Merriam, 1992).

These studies generally find smaller decrements than would be suggested by cross-sectional data, only small average decline in the sixties, with increasingly steep decrements for each successive age decade. There is also a strong suggestion that decline accelerates as a precursor of eventual death (Berg, 1996; Bosworth et al., 1999). But most importantly, all of the studies call attention to vast individual differences in rate of change occurring for individuals of all levels of early psychological functioning and socioeconomic status. Thus, although the frequency of individuals who show some decline increases at a near logarithmic rate once the sixties are passed, there are still rare individuals to be found even in their mid eighties who function exceedingly well. What many of these studies also suggest is that there may be an individualized pattern of developmental trajectories (cf. Magnusson, 1998). For example, in the case of mental abilities, most individuals by the time they reach the sixties will have experienced a significant drop in one of their abilities, but that ability will be specific to the individual (Schaie, 1989). Indeed, it is only from the longitudinal study of adult development that it is possible to enquire into possible mechanisms and/or causes of these vast individual differences in developmental progressions through adulthood.

Structural Invariance of Constructs Across Age

One of the bothersome problems in studies of adult development has been the ever-present question whether we are not comparing apples and oranges when we do age-comparative work. The experimental aging literature is replete with studies that compare college studies with senior volunteers. Fashionable also have been the so-called Brinley plots, in which mean performance of young adults and older persons across tasks of varying difficulty have been charted in order to obtain ratios that define the extent of the disadvantage of the older group (e.g., Cerella, 1990). All this work is based on the assumption that the

constructs studied (and technically the regression of the constructs on the marker variables used to measure them) remain invariant across the different groups or, in longitudinal studies, within groups (cf. Meredith, 1993).

The advent of confirmatory factor analysis has made a formal test of structural invariance across age practicable, and there have been a number of recent studies that have applied these methodologies to problems in adult development. The limited literature thus far available gives some reassurance, but also grounds for caution. Although good invariance has been demonstrated across much of midlife, there are significant structural differences between young and old adults, as well as between elderly men and women (e.g., Maitland, Intrieri, Schaie, & Willis, 2000; Schaie et al., 1998). However, there are selected marker variables that seem to be remarkably stable across the entire age range, which therefore deserve special attention. These marker variables include unspeeded measures of vocabulary (ETS Advanced Vocabulary), as well as selected markers of inductive reasoning (PMA Letter Series), spatial orientation (STAMAT Object Rotations), and numeric ability (ETS Subtraction and Multiplication).

Sources of Individual Differences

The differences in individual trajectories and patterns of decline invite investigations of potential causes of unfavorable or successful aging. Although some of these influences can be represented by psychological constructs, others must clearly be sought in the physiological infrastructure underlying effective behavior, as well as the sociodemographic factors that will either benefit or constrain individual development. The development impact of all of these influences can, of course, only be assessed by means of longitudinal data.

Not all individuals decline in lock-step. Although linear or quadratic forms of decline may be detectable for large groups, individual decline appears to occur far more frequently in a stair-step fashion. Individuals will have unfavorable experiences, to which they respond with a modest decline in cognitive functioning, and then tend to stabilize for some time, perhaps repeating this pattern several times prior to their demise.

Genetic Influences

Certainly, genetic endowment will account for a substantial portion of individual differences. For example, evidence of heritability of adult intelligence has been provided from both twin studies (e.g., Finkel, Pedersen, McGue, & McClearn, 1995) and family studies (e.g., Schaie et al., 1992). Similarly, genetic variance has been identified for a variety of personality traits as well as their stability in adulthood (e.g., Pedersen & Reynolds, 1998). Nevertheless, in most populations sampled, heritability explains on average at most 25% of cognitive abilities and less in the realm of personality. Hence, there are many other impor-

tant sources of individual differences in psychological aging that have been implicated.

Chronic Disease

The onset of intellectual decline seems to be markedly affected by the presence or absence of several chronic diseases. Most reliably identified as such influences thus far are cardiovascular disease, diabetes, neoplasms, and arthritis. All of these diseases are risk factors for the occurrence of early cognitive decline, as is a low level of overall health. Persons functioning at high cognitive levels are also more likely to seek earlier and more competent medical intervention in the disabling conditions of late life, and they are more likely to comply more effectively with preventive and ameliorative regimens that tend to stabilize their psychological infrastructure. They are also less likely to engage in high risk lifestyles and to respond more readily to professional advice that maximizes their chances for survival and reduction of morbidity (e.g., Bosworth & Schaie, 1999).

Environmental Circumstances

Other candidates of circumstances that might account for individual differences in cognitive aging, for example, have been all those aspects of the environment that are likely to enhance intellectual stimulation (cf. Schaie & O'Hanlon, 1990). Considerable evidence suggests that the onset of intellectual decline is postponed for individuals who live in favorable environmental circumstances, as would be the case for those persons characterized by a high socioeconomic status. These circumstances include above-average education, histories of occupational pursuits that involve high complexity and low routine, and the maintenance of intact families. Likewise, risk of cognitive decline is lower for persons with substantial involvement in activities typically available in complex and intellectually stimulating environments. Such activities include extensive reading, travel, attendance at cultural events, pursuit of continuing education activities, and participation in clubs and professional associations (Arbuckle, Gold, Andres, & Schwartzman, 1992; Gribbin, Schaie, & Parham, 1980).

Intact families, our most important individual support system, also reduce risk of cognitive decline. In addition, it has been found that cognitive decline is less severe for those married to a spouse with high cognitive status, with the lower-functioning spouse at the beginning of a marriage tending to increase his/her levels vis à vis the higher-functioning spouse (Gruber-Baldini, Schaie, & Willis, 1995).

Cognitive styles. Associated also with differential intellectual aging have been individual differences in the cognitive style of rigidity-flexibility. It can now be concluded that an individual's self-report of a flexible personality style at midlife, as well as flexible performance on objective measures of motor-cognitive perseveration tasks, is predictive of a reduction in the risk of cognitive decline. It seems that the availability of a more flexible response style is useful when one must cope with the vicissitudes of advanced age.

Perceptual and response speed. Aging effects on many cognitive abilities tend to be confounded with the perceptual and response speed required to process the tasks used to measure these abilities. Thus, individuals who remain at high levels of perceptual speed are also at an advantage with respect to the maintenance of such other abilities.

Life satisfaction. Finally, those individuals who rate themselves as being satisfied with their accomplishments in midlife or early old age seem to be at an advantage when assessed at a later age. Also, individuals who overestimate the rate of their cognitive decline might well be engaging in self-fulfilling prophecies if they reduce their active participation in life to compensate for decline that is perceived by the individual but has not actually occurred.

Developmental Interventions

Once we understand some of the factors that influence individual differences in adult development, we are then challenged as scientists to attempt obtaining experimental control by means of targeted interventions. Although investigators in child development might be interested in accelerating normal development of children's competencies, adult developmentalists' primary goal is to postpone functional decline or compensate for cohort differences (see later).

An essential feature of the design of interventions with older adults is the need to determine whether the individual has declined from a previously attained higher level or whether he/she is simply functioning at a low level that represents that person's developmental asymptote. If longitudinal data are available, it becomes possible to determine not only whether an intervention has resulted in improved levels of function, but also to determine whether remediation or new learning has occurred. And, again, only longitudinal studies can inform us whether or not developmental interventions have had long-lasting effects (cf., Willis & Nesselroade, 1990; Willis & Schaie, 1994).

The Impact of Generational Differences

One of the major contributions made by developmentalists interested in adulthood has been the attention given to generational (or cohort) differences in

psychological characteristics, including shifts in the rate of developmental change across successive cohorts. What is at issue here is that we cannot be certain that once we have explicated developmental mechanism and life course trajectories that these will stay put. As Riley (Riley et al., 1999) vividly portrays, changing societies change the life course of individuals, who in turn during their lives modify the formative nature of society. The cohort issue has long been of central concern in sociology and demography. In developmental psychology, cohort was first seen as a confound that created unwelcome discrepancies between cross-sectional and longitudinal findings. Hence, initial concerns with attempts to control for what were perceived to be "experimental artifacts,"

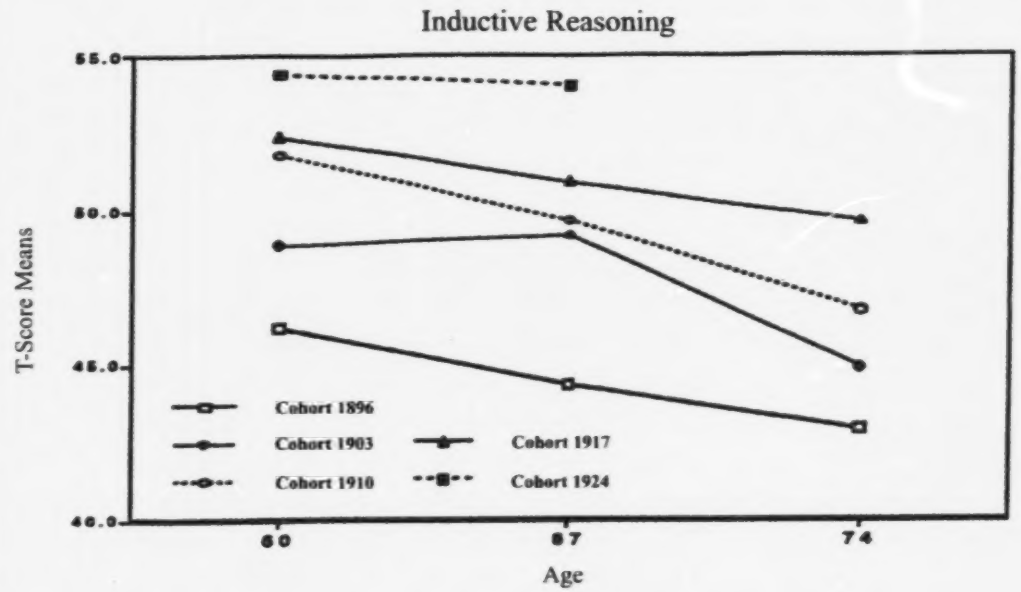
Cohort variance in studies of infancy and childhood may indeed be no more than a minor disturbance unlikely to overshadow or hide universal developmental laws. By contrast, cohort variance often assumes a substantively meaningful role in the study of adult development. Individual differences in adulthood, prior to advanced old age, are largely moderated by environmental context (see earlier). We therefore need to understand how successive cohorts differ from one another (Schaie, 1996a; Willis, 1989). Examples of major contexts that differ dramatically for successive generations are level of educational attainment, adoption of healthy lifestyles with respect to exercise and diet, and major advances in health care that contribute to the extension of life and functionality. The increase in societal support during early old age has resulted in compensatory behaviors that optimize selective psychological functions (cf. Baltes & Carstensen, 1996). The increased functionality, however, also expands demands by society on the individual's development.

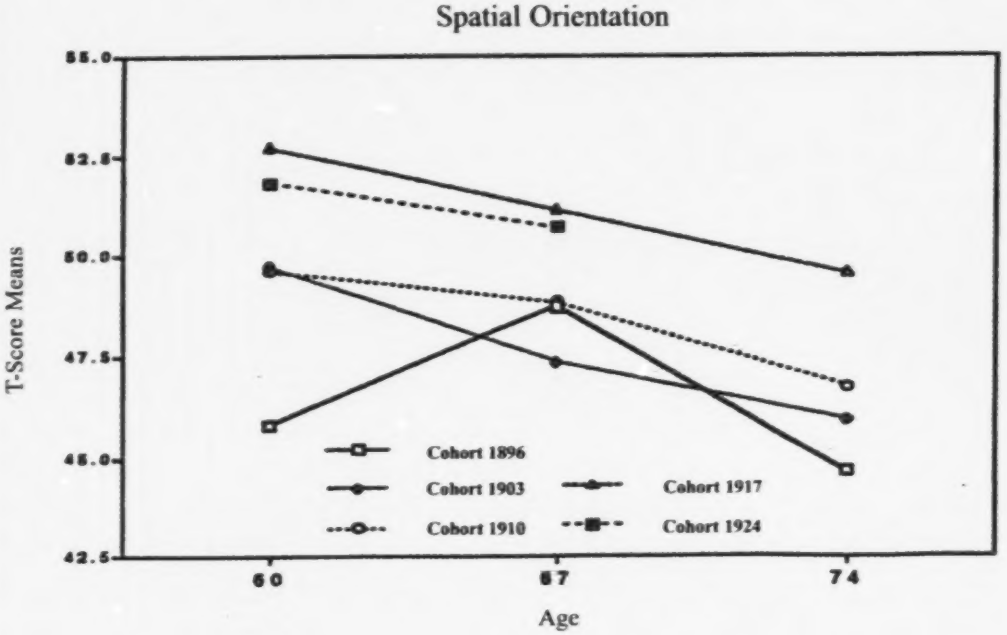
An example of this interplay can be seen in the current discussions on delaying eligibility for Social Security payments in the United States. It is argued that individuals both live longer and remain functional to later ages than in the past. Facing the developmental psychologist is the question as to what assumptions need to be made to buttress these contentions. I would argue that two assumptions are required. First, it is necessary to show that older individuals function at higher levels today than in earlier eras, and second, evidence is needed that the rate of declining competence has slowed for successive cohorts. Figure 2 shows some relevant data from the Seattle Longitudinal Study bearing on these questions.

What should be noted in Figure 2 is the pattern of increased levels of performance on two important dimensions of cognitive competence (Inductive Reasoning and Spatial Ability) for successive cohorts over the age range from 60 to 74. This, of course, is the age span during which most individuals could typically be expected to retire, and the data support the assumption that performance over this age range has indeed risen. On the other hand, there is little support for the second assumption of changes in rates of aging. The data suggest that the rate of change from age 60 to age 74 has not changed markedly over what represents an almost 30-year period of time.

Figure 2

Changes in level and rate of aging across five cohorts for the mental abilities of Inductive Reasoning and Spatial Orientation.





Future Implications

The study of adult psychological development is increasingly informed by relevant neighboring disciplines that investigate the genetic basis, physiological infrastructure, and societal context of the developing individual. Hence, I would predict that the study, over the life course, of single psychological variables that was common in the first two-thirds of the 20th century will be largely displaced by multivariate multidisciplinary efforts. Indeed, most of the more recent longitudinal studies of adults already display these characteristics (e.g., Baltes & Mayer, 1999). Cross-sectional investigations will continue to have a role as exploratory pilot studies or as the first stages of prospective longitudinal studies. Given the willingness of public agencies to invest in more comprehensive investigations we are likely to see more programmatic long-range investigation that may frequently include experimental paradigms and, in particular, interventions designed to modify rate of development.

With our increasing sophistication in psychological measurement, we will take advantage of the work on structural invariance to develop better scales. The introduction of item response theory to educational measurement was instrumental in improving the precision of measurement scales and their applicability to populations at different stages across the range of human talent. But item response theory remains essentially a univariate procedure, and its proponents have not yet dealt with matters such as changes in item differences across age and time. Once we have used confirmatory factor analyses to identify those robust marker variables that do well in measuring behavior across the entire adult lifespan we must then return to improving the measurement characteristics of those scales that we will continue to use.

We are beginning to develop common archives that will make available to our colleagues large datasets from many different populations and covering a wide range of psychological attributes. This development calls even more urgently for the development of "gold standards" for a core set of measures. Such measures can then be used to link disparate datasets and provide the basis for substantively meaningful meta-analyses.

I would also predict that the investigation of adult development will increasingly turn to the identification of mechanisms and processes that underlie developmental interventions and that will be relevant to public policy questions. Many of the mechanisms that may lead from full functionality to increasing impairment are likely to become first measurable in midlife (cf. Willis & Reid, 1999). Paradoxically, such investigations may rekindle interest in age-comparative and short-term longitudinal studies, so as to be able to respond to societal problems of an immediate nature. However, age-comparative studies of this nature will not use the young/old comparison paradigms currently so common in the experimental literature. Rather, they must introduce designs that compare groups differing modestly in age; hence, making it possible to control or match

for other individual difference variables. We should thus see more studies comparing different segments of midlife and of old age, rather than investigations attempting to cover broad age slices.

Recent theorizing on losses and gains in advanced old age (cf. Baltes, 1997), suggests that we have been successful in identifying and introducing behavioral and environmental compensations for the increasing physiological frailness all of us can expect as we age; these seem to work well in early old age. We have been far less successful in dealing with the needs of the very old, where the compensatory methods that may work well at retirement no longer suffice. Some would argue that the only solution here is to find ways to enhance the spiritual experience and psychological accommodation of the very old to the reality of end-of-life losses. Nevertheless, my inveterate optimism would argue that even here other possibilities for successful interventions may still lie ahead. Hence, studies of the very old, including investigation of behavioral and environmental prostheses, would seem to be part of the need for a strong applied psychology of adult development, one that will find ways to enhance the quality of our existence towards the very end of human existence.

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Theories of Everyday Competence and Aging

K. Warner Schaie and Sherry L. Willis

Everyday competence in adulthood represents an important but complex domain of inquiry. The theoretical framework needed to organize and provide explanatory principles is equally complex. What is required is an account that explains how an individual can function effectively on the tasks and in the situations posed by everyday experience (cf. Willis & Schaie, 1986). To do so, the theoretical framework must incorporate underlying processes, such as the mechanics and pragmatics of cognitive functioning (cf. P B. Baltes, 1987; Sternberg, 1977; Sternberg & Berg, 1987), but it must also include the physical and social contexts that constrain the individual's ability to function effectively.

Our position will be that a hierarchical model of competence must begin with the underlying dimensions of the cognitive processes that are basic to all meaningful behavior. Given the particular task attributes and constraints in an everyday situation, different combinations and permutations of basic cognitive skills will be required to successfully display competent behavior.

Alternative theoretical models that incorporate some or all of these features will be elaborated. We then ask how developmental changes in the various components constituting our theoretical framework will help us predict how everyday competence is likely to be maintained or to change with advancing age.

Historically, psychologists have addressed the study of competence by suggesting that an understanding of the wide array of dimensions of cognitive abilities would suffice to explain competence in everyday activities (Thurstone, 1938). Connolly and Bruner (1973) expanded the delineation of competence as a construct that implies action that may change the environment as well as adapt to the environment. They suggested that attributes of competence involved, first, the ability to select those features from the total environment that are required information for initiating a course of action; second, initiating a sequence of movements designed to achieve the planned objectives; and third, learning from successes and failures to form new plans.

From the above considerations it may be argued that competent behavior involves the application of cognitive mechanisms in specific situations, whose attributes may in turn interact with the developmental level of the individual. Because basic cognitive processes are typically operationalized so as to repre-

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sent unitary trait characteristics, it is unlikely that any single process will suffice to explain individual differences in the exertion of everyday competence in any particular situation (Willis & Schaie, 1993). Hence, everyday competence could be characterized as the phenotypic expression of basic cognitive processes, which, given minimally required levels of motivational incentives, will permit adaptive behavior in a specific everyday situation or situations (Schaie, 1978).

In recent years a number of alternative approaches have been taken to define everyday competence. These can be represented as three different theories of everyday competence: componential theories that argue for different latent dimensions of competence, theories that take a strictly domain specific approach, and those that are concerned primarily with the individual-environment fit. Because the definition of everyday competence has important societal implications, we next distinguish between psychological and legal definitions of everyday competence (cf. also Willis, 1996). We then address the question whether methods of measurement tend to drive theories of competence, and finally we present a view of competence within a life span perspective.

Theoretical Approaches to Everyday Competence

In this section we review three broad theoretical approaches to the study of everyday cognitive competence. The first perspective views everyday competence as a manifestation of latent constructs and as related to models of basic cognition. In the second approach everyday cognitive competence is conceptualized as involving domain-specific knowledge bases. In the third approach the focus is on the fit, or congruence, between the individual's cognitive competency and the environmental demands faced by the individual.

In all three approaches the focus is on problem solving with respect to everyday, real-world activities and demands. The concern is with the individual's ability to carry out the cognitively challenging activities of daily living. In this chapter we will be primarily concerned with the cognitive aspects of everyday competence. It is important, however, to acknowledge that the functional competence (Fillenbaum, 1987; Lawton & Brody, 1969) required to carry out everyday activities is multidimensional, involving physical and social as well as cognitive components. Medication compliance, for example, involves not only cognitive processes such as memory and reasoning but also the sensory ability to read the label, manual dexterity to open the bottle and measure the dosage, and social support.

Competence: Manifestation of Latent Constructs and Linkage to Basic Cognition

Within this approach we group such diverse perspectives as componential and hierarchical models of competence and theories of postformal stages of

development (P. B. Baltes, Dittman-Kohli, & Dixon, 1984; Berg & Sternberg, 1985; Labouvie-Vief, 1992; see also Park, 1992). These diverse perspectives share some common themes.

First, each of these perspectives establishes a link between more basic forms of cognition and everyday competence. Within the componential and hierarchical approaches, the association of everyday problem solving with either psychometric intelligence or information processing approaches is considered. In the study of postformal thought, consideration is given to the evolution of relativistic or dialectical forms of thinking from formal operational thought.

Second, in this perspective competence is studied and assessed in terms of latent cognitive constructs. Observable everyday tasks/problems are seen as markers of these latent constructs. Competence is multidimensional in that there are multiple components or hierarchical levels, each represented at the latent construct level.

Third, everyday competence is not conceptualized in terms of specific substantive domains. Rather, competence in various everyday activities (e.g., managing finances, medication adherence) is seen as involving a parsimonious set of cognitive abilities or processes that cut across or apply to various substantive domains.

Fourth, the latent constructs perspective is concerned with age-related change and developmental trajectories in everyday competence. The developmental trajectories are determined in part by the particular model of basic cognition that serves as the underpinning of each perspective. For example, perspectives linked to basic cognitive processes such as speed of processing (or fluid) intelligence may be particularly concerned with decline trajectories. In contrast, postformal thought is concerned with more advanced or optimal levels of cognition.

Fifth, the role of the environment or context is of particular salience in determining the particular types of applied activities and problems in which everyday competence is manifested. Both the sociocultural context and the microenvironment determine the genotypic expression of everyday competence for a cohort or a given individual. For example, whereas ability to transport oneself beyond one's dwelling has been of concern through the ages, the ability to comprehend airline schedules and to operate computer-driven vehicles is only a recent expression of everyday competence with regard to mobility. The environment also plays an important role in the maintenance and facilitation of everyday competence in old age. Environmental stimulation and challenges occurring either naturally or through planned interventions have been shown to be associated with the maintenance and enhancement of everyday competence in the elderly.

One way in which various exemplars of this perspective differ is with regard to the model of more basic cognition with which they seek linkages. Sternberg and co-workers (Berg & Sternberg, 1985; Sternberg, 1985; Sternberg & Kolligian, 1990) have proposed a triarchic theory of adult intellectual development that involves metacomponents and experiential and contextual aspects. The metacomponential part of the theory is rooted in an information processing approach to cognition. This part of the theory is concerned with basic cognitive processes such as encoding, allocation of mental resources, and monitoring of thought processes. Of greater relevance to everyday competence are the experiential and contextual aspects of the theory. The theory posits that the metacomponential processes operate at diferent levels of experience with a task. The two levels of the theory that are of greater relevance for everyday competence have to do with whether the components are operative in a relatively novel fashion or are in the process of becoming automatized. According to Sternberg (1985), the most intelligent person (in this case having higher everyday competence) is one who can adjust to a change in problem situations and who can eventually automate the component processes of task solution. The third aspect of the theory is concerned with how the individual relates to the external world—the ability to apply the metacomponents at different levels of experience in adjusting to a change in the environment. Whether competence in a particular everyday activity declines or not would depend in part on the nature of environmental change and the ability of the individual to apply metacognitive processes to adapting to the change.

In a somewhat similar approach, Baltes and colleagues (P. B. Baltes et al., 1984) have proposed a two-dimensional componential model of cognition. In contrast to Sternberg, Baltes has conceptualized the mechanics of cognition (what Sternberg calls metacomponents) in terms of psychometric abilities, rather than information processing. Everyday competence is more closely associated with the second component of the theory — the pragmatics of intelligence. Although the mechanics of intelligence serve as underpinnings for the pragmatic component, the environmental context is critical to the particular form or manifestation in which pragmatic intelligence is shown. Baltes posits that although the mechanics of intelligence decline with age, there is enhancement in the pragmatic component through much of adulthood. The concept of wisdom has been linked and studied within the pragmatics of intelligence (Staudinger, 1996).

In our own work we have conceptualized a hierarchical relationship between basic cognition and everyday competence (Willis, 1987, 1996; Willis & Schaie, 1986, 1993). Basic cognition has been represented by domains of psychometric intelligence, such as the second-order constructs of fluid and crystallized intelligence and the primary mental abilities associated with each higher order con-

struct. Like Berry and Irvine (1986), we propose that the cognitive abilities represented in traditional approaches to intelligence are considered universal across the life span and across cultures. When nurtured and directed by a favorable environment at a particular life stage, these processes and abilities develop into cognitive competencies that are manifested in daily life as cognitive performance.

Everyday competence, as represented in activities of daily living, are phenotypic expressions of intelligence that are context- or age-specific. The particular activities and behaviors that serve as phenotypic expressions of intelligence will vary with the age of the individual, that person's social roles, and the environmental context. Problem solving in everyday activities is complex and hence involves multiple basic cognitive abilities. For example, balancing one's checkbook involves verbal ability, inductive reasoning, and numerical skills. Our research has shown that significant variance in performance on everyday tasks can be accounted for by a combination of several basic abilities. The particular combination or constellation of basic abilities varies across different tasks of daily living. It is important to note that the basic abilities are seen as necessary but not sufficient antecedents for everyday competence (Willis, 1991; Willis & Schaie, 1993). Everyday competence also involves substantive knowledge associated with the particular everyday problem domain and the individual's attitudes and values with regard to the problem domain.

Postformal Forms of Reasoning

The postformal operational perspective has arisen as one that (a) is qualitatively different from prior forms or stages of reasoning, (b) develops in adulthood, and (c) is of particular interest in later adulthood. Of particular concern is the developmental timing of manifestation of this form of reasoning and the demonstration that it is different and often superior to prior forms of reasoning.

Labouvie-Vief (1992) and colleagues (Labouvie-Vief & Hakim-Larson, 1989) have proposed the development, in middle and later adulthood, of a more pragmatic, concrete, and subjective approach to reality. This mode of thinking reflects sensitivity to the interpersonal context and thus focuses on inner, personal experience. The study of cognitive aging until recently has focused almost exclusively on a youth-oriented mode that thinks of reality in a formalistic, abstract, and objectified manner. A vertical or hierarchical, rather than balanced or integrated, ordering of the two modes of thought were imposed. Pragmatic, emotive modes of thinking were devalued or subjugated. In adulthood there is the unique potential to integrate optimal use of both modes of thought. In related work, Blanchard-Fields (1986) has suggested that quantitative assessments of everyday competence or reasoning fail to tap the richness and complexity of older adults' thoughts and social attributional processes. Older adults use their

postformal operational reasoning selectively, and such use is likely to occur in everyday problems that are emotionally salient and pertinent to their lives.

How Do These Perspectives Differ?

In spite of the commonalities earlier noted in this section, there are certain basic differences that may lead to competing research strategies and predictions. The Sternberg and Baltes positions are both parallel theories of competence; they suggest that there are different dimensions that conjointly affect everyday behavior but are weighted differentially for specific task demands and situations. The Willis-Schaie position is essentially a hierarchical model that argues for the aggregate importance of different combinations of basic cognitive processes as they apply to specific task demands and situational constraints. All these theories are continuity models: as adults age, certain processes may be weighted in a differential manner, but the latent constructs involved remain the same throughout the life span. By contrast, the postformal reasoning position represents developmental discontinuity by suggesting the importance of qualitative transformations, which may be unique to adulthood, as well as the increasing role of emotions as a major factor in everyday competence.

Competence as Domain-Specific Knowledge and Problem Solving

A second theoretical perspective conceptualizes competence as involving the development and organization of an increasingly complex and well-integrated body of knowledge that is domain-specific (Salthouse, 1990). Several themes associated with this approach can be identified. First, in contrast to the latent construct perspective, competence is considered to be domain-specific, that is, limited to a particular body of knowledge or substantive area. Second, the focus is not on identifying components or latent ability constructs but on describing the manner in which a problem is represented and the increasingly complex manner in which information is related and organized. Third, there is little focus on broad developmental trajectories. Rather, competence is seen as increasing as the amount of information grows and the organization of the knowledge becomes more integrated and complex. In later adulthood, everyday problem solving is seen as developing out of the older adult's familiarity and experience with problems within a specific life domain (Park, Morrell, Frieske, & Kincaid, 1992; Rybash, Hoyer, & Roodin, 1986).

Adults are seen as active problem solvers who construct a representation of both the problem and the process or strategies involved in solving the problem (Chi, 1985; H. Leventhal & Cameron, 1987). The adult's representation of the problem and of its solution involves factors that may vary with the type of problem being solved. A distinction is made between well-structured and ill-structured problems. In well-structured problems, research has focused on (a) declarative knowledge, the body of domain-specific knowledge possessed by the

adult, and (b) procedural knowledge, the problem-solving strategies and skills that are relevant to the particular problem. In ill-structured problems, the problem is not well defined, allowing alternative solution strategies.

Research on ill-structured problems has often focused on adults' cognitions and beliefs about the problem and about solution or treatment alternatives (H. Leventhal & Cameron, 1987; Voss & Post, 1988). Some have argued that real-life problem solving is more closely associated with ill-structured problems (Sinnott, 1989; Sternberg & Wagner, 1986; also see Willis & Schaie, 1993, for an alternative view). Given their extensive lifetime experiences, the old might be expected to have larger stores of knowledge and to have hierarchically organized knowledge bases that are well integrated and that utilize lesser amounts but qualitatively higher order types of information.

Findings in support of the above hypotheses are mixed. Some studies report age-related reductions in the amount of information used and the extensiveness of the information search process undertaken by the old. Meyer, Russo, and Talbot (1995) examined decision making with respect to a health scenario about breast cancer. Older women had no greater prior domain-specific knowledge about breast cancer and remembered less information presented during the study. They sought less information before making a treatment decision. When given further information, older women typically did not change their initial treatment decision. In contrast, younger women were more likely to seek additional information while delaying a decision about treatment and more likely to compare and contrast various types and sources of information. In spite of these differences in use and recall of information, older women made the same decision regarding treatment as did middle-aged and young women. The older women reached the same decision based on less information earlier in the decision-making process.

Studies of managerial and of consumer decision making have found somewhat similar patterns of findings regarding age differences in problem solving (Schaninger & Schiglimpaglia, 1981; Streufert, Pogash, Piasecki, & Post, 1990). In a study of age differences in seeking medical care, the elderly were less likely to seek information from outside sources prior to contacting their physician and to contact their physicians earlier than did middle-aged individuals (E. A. Leventhal, Leventhal, Schaefer, & Easterling, 1993).

It should be noted that the domain-specific approach is essentially nondevelopmental. That is, competence is thought to arise out of automatization, prior experience, and the development of expertise. Hence, there are difficulties in accounting for age changes or age differences in competence that must be related to shifts in underlying physiological and psychological processes characteristic of normal aging.

Everyday Competence as the Person-Environment Fit

The third theoretical perspective to be reviewed is concerned with the degree of congruence between the abilities of the individual and the demands and resources available in the environment (Kahana, 1982; Lawton, 1982, 1987; Parmelee & Lawton, 1990). Competence does not reside solely in the individual nor in the environment. Competent behaviors occur when the capabilities of the individual match the environmental demands and resources. Hence, an older adult with some cognitive limitations may appear competent with respect to everyday activities when functioning in a supportive environment with many resources. In contrast, even the most capable individual appears less competent when functioning in a very demanding, resource-limited context. A loss of competence resulting from incongruence between the individual and the environment may reflect decreases in the abilities of the individual, changes in environmental demands or resources, or a combination of these.

The research on person-environment fit has examined the effects of different environments on older adults' ability to live independently, as well as on their morale and life satisfaction. Carp (1987) has suggested that the notion of fit should be considered at two levels. At the lower level are life-maintenance needs such as food, water, and adequate shelter. Fulfillment of these basic needs depends on the degree of fit between the person's ability to perform basic activities of daily living (ADLs; bathing, toileting, feeding) and environmental resources. If the person is limited in these basic self-maintenance activities, then increased environmental support is needed to achieve a basic level of competence. Once these basic needs are met, the match between person and environment may then focus on the fit between the individuals' higher order needs and desires and the environmental resources.

Higher order needs may include the level of affiliation and social contact desired, need for privacy, and preferences for rural versus urban settings. With regard to affiliation, an appropriate match would involve a person with a strong desire for interpersonal contact living in a highly social environment. The impact of lack of congruence between the needs and desires of the individual and the environmental resources is illustrated in Carp's (1987) research on older persons moving to a new apartment facility. Older adults who, before moving, manifested the highest level of sociability were the ones most socially active after the move. Those who had been least socially active displayed even lower levels of socializing after the move. The inference is that those who were less comfortable in the closer environment of a housing project (greater incongruence between personal preferences and environmental conditions) withdrew and became more isolated. In contrast, those high on sociability took full advantage of increased contact with others and additional social activities.

The theoretical importance of the person-environment fit model lies in its ability to account for individual differences in competence in old age that can

not be strictly attributed to the decay of the mechanics of cognition or the obsolescing of the information required by individuals to function adequately. It adds the important contextual dimension often ignored in person-centered developmental theorizing.

Psychological Versus Legal Competence

The previous section has reviewed three theoretical perspectives that characterize psychological approaches to the conceptualization and study of everyday competence. But psychological theories ought not to be mere sandbox exercises. Instead, they should abstract and systematize phenomena that are meaningful to real-world experience. In this section we briefly discuss how theories of psychological competence relate to the theoretical definition of competence as used in legal proceedings. Legal competence is of significant practical importance because the legal determination of loss of everyday competence may result in legal judgments of guardianship or conservatorship. As we shall see, cognition is a critical aspect of legal judgments of competence. Interestingly, both legal and psychological considerations of competence have focused on two broad domains: competence with respect to the safety and well-being of the person and competence to manage one's property. In the social sciences, competence to care for oneself has been conceptualized and assessed in terms of the Activities of Daily Living (ADLs; Katz, Ford, Moskowitz, Jackson, & Jaffee, 1963), including the ability to bathe, feed, toilet, and transport oneself. Management of one's affairs has been conceptualized to represent seven domains of ADLs defined as Instrumental Activities of Daily Living (IADLs; Lawton & Brody, 1969). These include the ability to use the telephone, shop for necessities, manage one's finances, prepare meals, manage one's medications, care for one's home, and transport oneself outside the home.

Legal determinations of inability to care for oneself often lead to appointment of a guardian, and incapacity to manage one's affairs may lead to appointment of a conservator. Grisso (1986) and others have argued that IADLs are of primary interest in legal guardianship cases. The elderly person may be able to engage in basic self-care activities and still have serious deficiencies in making decisions regarding independent living and management of property.

Definitions of legal competence are based on the need of the jurisprudence system to determine when a state legitimately may take action to limit an individual's rights to make decisions about his or her own person or property (Sabatino, 1996). Because the legal presumption is that adults are best able to decide what is in their best interest and ought to be left alone to pursue their own choices (Meisel, 1989), the burden of the judicial system is on determining incompetence. Hence, legal definitions have focused largely on incompetence or incapacity, whereas psychological definitions are framed positively in terms of competence. Judgments regarding incapacity have recently become limited in

scope to only certain domains of the person or property, such as financial management or health decision making. Global determinations of guardianship or conservatorship were more common in the past and reflected a concern with global incompetence.

In the legal system there is no national consensus on a standard for declaring an individual to be incapacitated (Anderer, 1990), just as there is little consensus in the social sciences on definitions of competence; statutes regarding competence vary widely from state to state. However, in both fields there is growing recognition of common themes or elements that are employed in conceptualizing and assessing competence (Altman, Parmelee, & Smyer, 1992: Grisso, 1986, 1994; Kapp, 1992; Sabatino, 1996; Willis, 1996). Of interest in this segment of the chapter are the similarities and differences between legal and psychological conceptions of competence.

Common Elements in Definition of Competence/Incompetence

At least four common themes or elements are frequently found in laws regarding guardianship and conservatorship and hence competence (Grisso, 1986, 1994; Sabatino, 1996).

1. Assignment of status or disabling condition. Until recently, a primary element in judgments of incompetence was the labeling or designation of a status for the individual. Courts and juries had the discretion to bestow the labels such as idiot, insane person, and lunatic on the individual, with the assumption that the label implied incompetence. Progressively state laws have refined the status approach in two respects. First, a more medicalized approach to defining a disabling condition has replaced the designation of a status. Second and more recently, some states no longer accept simply the identification of a disabling condition but require in addition a finding that the disabling condition has caused some dysfunctional behaviors (Parry, 1985).

2. Cognitive functioning. In some states the focus on a disabling condition (e.g., dementia) has been replaced with an emphasis on a more precise description of deficiencies in cognitive functioning. The critical aspect of cognitive functioning has been the individual's capacity to understand and to make and communicate responsible decisions; hence, legal definitions of competence are closely aligned with the forms of everyday problem solving of concern to psychologists. Cognitive functioning has been particularly salient in health care decision making and in advance directive statutes. Capacity with regard to health care decisions has been defined as the ability to understand the significant benefits, risks, and alternatives to proposed health care and to make and communicate a health care decision (Uniform Health-Care Decisions Act, 1993).

3. Functional or behavioral impairment. Recently, it has been argued that diagnosis of a disabling condition or poor performance on cognitive measures is

insufficient for judging a person to be incompetent and for appointment of a guardian. The focus is on behavioral manifestations of incompetence rather than on less direct indicators such as diagnosis or mental tests. Thus, legal assessment of competence is following a trend similar to that in the social sciences — focusing on behavioral or performance indicators of problem solving and decision making rather than on measures of basic abilities and processes.

4. Competence as congruence of person and environment. Legal judgments are not concerned with assessment of absolute competence but rather with whether the individual is capable of functioning in a particular environment. The question is whether the person is capable of meeting his or her essential needs for survival and is not endangering self or others in the current environment. Thus, competence in the legal sense does not reside solely in the individual but in whether the individual can survive and avoid risk of endangering self or others in a given context. Appointment of a guardian or conservator is seen as enhancing the environmental dimension when the individual's capabilities are not deemed sufficient in the present environment.

It may be noted that legal theorizing incorporates aspects of virtually all of the psychological theories of competence discussed earlier in this chapter. To the extent that these theories provide credible explanations, they also tend to affect and modify legal practice.

Do Methods of Measurement Drive Theories of Competence?

As is true in other areas of gerontological theorizing, models built to systematize and explain empirical data are often driven by the methods of measurement used to collect such empirical data. At least three different approaches to the measurement of competence can be recognized. The first approach is open-ended, utilizing subject-generated responses and/or relying on the ability of rater-derived observations or judges' ratings of more global responses to determine the nature of competence as well as to judge the level of competence displayed by a particular individual. The second follows the psychometric tradition of building measurement models that dimensionalize the latent construct(s) of interest. Such models must of necessity involve objective assessment strategies that assume scientists can characterize response dimensions and specify appropriate (correct) subject response. A third approach is concerned with the person-environment fit, that is, the interaction between the actions of the individual (everyday competence) and the complexity or supportiveness of the context. The latter approach, of course, requires measurement of situations (environments) as well as performance of the individual.

Subjective Ratings

One way of measuring everyday competence is to consider whether a person "behaves" in a competent manner (Goodnow, 1984). Such an approach, of course, requires the use of judges to determine the attributes of everyday competence prevalent at various life stages (e.g., Berg & Sternberg, 1985). These attributes represent ways in which people combine or organize information about everyday events (Goodnow, 1986) or how psychologists perceive their own functioning (Mason & Rebok, 1984). Theories derived from taxonomies developed by judges or by various multidimensional scaling approaches tend to be essentially "nativistic." That is, they represent explications of the stereotypic conceptualization of the persons generating them. Hence, rating-derived theories may be quite specific to the age, social class, work setting, or other contextual dimensions of the raters and the target population (Scribner, 1984). One such prominent taxonomy that has widely influenced the field are the dimensions represented by the ADL and IADL checklists (Fillenbaum, 1985; Lawton & Brody, 1969). The IADL checklist in particular has been used widely to determine whether older individuals can function independently in the community as well to determine limitations on particular dimensions such as managing finances, using medications appropriately, using transportation, communicating via the telephone, being able to engage in household chores, and being able to shop and prepare food.

Subjective approaches to the definition of domain content play an important role in theory development and may be an essential first step in devising models that can be more formally operationalized with objective methods of assessment. Such methods provide the basis for data collections on which the viability of the theories can then be tested.

Objective Assessment

Objective measures for the assessment of everyday competence have been developed for quite some time. Early examples of such work are scales sampling everyday activities by Demming and Pressey (1957) and by Gardner and Monge (1977). Another set of items that has been used in aging research comes from the efforts of the Educational Testing Service (1977) to assemble an objective measure of competency in everyday tasks for high school graduates. This measure contains materials related to interpreting medicine bottle labels, bus schedules, road maps, Yellow Pages advertisements, warranties, newspaper editorials, and the like. Age changes on this global measure of everyday competence have been found to be comparable to those seen for fluid abilities (Schaie, 1996).

Willis and her colleagues (Marsiske & Willis, 1995; Willis & Marsiske, 1991; Willis & Schaie, 1993) have conducted an extensive program to opera-

tionalize objective assessment tools for each of the IADL domains, using printed materials that older persons must be able to deal with successfully in each of the seven categories. The plausibility of this measurement system was assessed by confirmatory factor analysis, as well as by replicating assessment with physical stimulus materials contained in older persons' homes (Diehl, Willis, & Schaie, 1995).

Just as subjective explorations may inadvertently bias the development of theoretical models and thus incorporate stereotypes that are largely time-, population-, and place-bound, so may objective measurement systems constrain the manner in which everyday competence is defined to the domain content of such measurement systems. Further restrictions are often introduced by the demand for ever more parsimonious assessment systems, which tend to lead to assessment procedures that, by their very nature, will be global. These procedures, in turn, may lead to the inappropriate inference that everyday competence is a unitary construct, even though we know intuitively and from empirical evidence that a multidimensional system of constructs must be involved to account for the complexity of human experience.

Person-Environment Fit

Given our definition of everyday competence as involving adaptive behavior within specific contexts, we now must consider the implications for theory of how to measure the context within which competence is displayed. A major approach to this issue has been the extensive literature on person-environment (P-E) fit (c.f., Lawton, 1982, 1989). In this approach it is sometimes argued that the action of persons within context can be treated only as P-E interactions; the effect of one on the other is seen as essentially reciprocal in nature. Nevertheless, the way in which the characteristics of the environment are described will obviously make a difference. For example, a number of efforts in this direction have appeared in the literature with respect to the characteristics of the physical environment (Regnier, 1997), of independent living arrangements (Carp & Christensen, 1986), and with respect to institutional environments (M. M. Baltes & Horgas, 1997; Moos & Lemke, 1985). Once again, whether the characteristics of such settings are measured as simple technical descriptors, as indicators of support, or along dimensions of dependency induction, such measurement will have theoretical implications for how the P-E interface is to be understood.

An alternative approach to contextual measurement is to take a quasi-ethnographic approach to discover the specific situations within which older adults are required to display competent behavior. This information can then be translated into a data language such as a Q-sort to discover the dimensions that are most likely to be perceived by older raters as characteristic of competency-demanding situations. In a study by Scheidt and Schaie (1978) situations were identified as ratable along the dimensions of social-nonsocial, common-

uncommon, supportive-depriving, and active-passive. Age differences in perceived competence were found in the direction of greater competence for the elderly in situations involving social, common, and depriving elements (Willis & Schaie, 1986). It was also found that different basic cognitive skills were related to perceptions of effective functioning in situations with different attributes (Schaie, Gonda, & Quayhagen, 1983). A situational competence model here would be driven by the perceived attributes of the context rather than by its objective descriptors.

Measurement strategies are important in driving theory in gerontology, because explanations must of necessity be based on how a domain of behavior is dimensionalized and whether objective or subjective experience is preferred for the source of one's data. Perhaps in the best of all possible worlds we would expect a dialectic process in which theory directs how we measure and in turn measurement impacts on theory.

Everday Competence Within a Life Span Perspective

We now come to the crux of the matter, namely, how should we advance theory development to better characterize the developmental course of everyday competence as we age? At least three aspects of such theory development must be considered. First of all, it must be stressed that the aging of everyday competence should be considered a dynamic process: competence of the individual as well as situational characteristics change both quantitatively and qualitatively over the adult life span. Second, adequate theoretical models must consider not only the level of functioning of the individual but also the matter of rate of change. Despite the remaining controversy over the importance of cohort differences in cognitive abilities and hence everyday competence, it seems likely that quantitative age differences in competence, prior to advanced old age, may to large extent be a function of obsolescence and cohort-related differences in opportunity structures. What is not clear, however, is whether there are also cohort-related differences in the rate of cognitive aging. The question of whether there has been a slowing of such change, particularly in advanced old age, remains open. Third, we need more theorizing about to what extent qualitative changes in the nature of individual response and in the characteristics of the eliciting situations contribute to apparently age-related differences in the display of everyday competence.

Clearly, whatever theory of everyday intelligence we care to espouse, we cannot escape the conclusion that decremental changes in the basic cognitive mechanisms will result in commensurate deterioration of performance of everyday tasks. To the extent that different psychological abilities decline at different rates, we will also expect to see differential change in everyday competence (Willis, Jay, Diehl, & Marsiske, 1992). In our research on the concurrent relationships between basic mental abilities and performance of cognitively

demanding tasks in various domains of everyday competence, we have found that over half of the individual-differences variance in older adults' performance can be accounted for by mental abilities (Willis, 1997; Willis & Schaie, 1994).

A developmental theory of everyday competence would predict that adults will reach their asymptotic competence in midlife, when virtually all the basic cognitive processes are at peak levels. We would first expect difficulties in early old age for those activities that have relatively brief response windows—the inexorable increase in reaction time is most noticeable as tasks take on increasing complexity. We would next expect difficulties in those everyday tasks that involve strong components of processes identified as fluid or visualization abilities. Everyday competencies that involve primarily verbal (or other crystallized) processes are, by contrast, likely to remain intact into advanced old age (cf. Schaie, 1996).

As we noted earlier, a comprehensive theory must also take into account the situational demands within which everyday competence must be exercised. These demands are likely to be life-stage-specific. Hence, lesser or greater amounts of underlying cognitive competence may be required. But we would also predict qualitative change in the situational context, depending on its complexity or supportiveness, that may permit the display of adequate everyday competencies even where cognitive resources have declined substantially. Moreover, motivational states and positive or negative shifts in the social support system (cf. Carstensen, Gross, & Fung, 1997) may markedly affect the expression of everyday competence.

We have previously described a stage theory of adult cognitive development that considers developmental changes in the demand context requiring adults' cognitive response (Schaie, 1977-78; Schaie & Willis, in press). The demand context defined by this theoretical model is also quite relevant for a theoretical framework of everyday competency. That is, the range of everyday competencies required of young adult or middle-aged individuals must necessarily differ markedly from those required of the old and very old. Just as a differentiation-dedifferentiation model fits the empirical data and makes sense for understanding the course of cognitive development (Reinert, 1970; Schaie, Maitland, Willis, & Intrieri, 1998; Werner, 1948), so we must consider a model for everyday competence whose ontogeny shifts from the simple demands of childhood, through the complexities of midlife, to a simplification of both situational context and extent of the individual life space in old age.

In the cognitive aging literature the process of development has been characterized by P. B. Baltes (1993) as selective optimization with compensation. We would propose that a similar process extends to everyday competence as well. Such a model would readily explain, for example, why 90-year-olds can make thoughtful dispositions of their personal property to selected friends and family members and at the same time are unable to take care of their financial affairs or engage in other IADLs that would be essential at an earlier life stage to success-

fully maintain independent living arrangements. We might conclude that everyday competence is of necessity constrained by the physical and cognitive capacity of the individual, the situational demands, and the environmental support that a given society deems appropriate at different life stages. We do not demand that children display competencies incompatible with their development stage. By the same token, competencies that we take for granted in midlife and early old age may well be inappropriate for the very old. Indeed, dependency and increased levels of societally approved support may obviate the display of many everyday competencies at both ends of life span.

Theory development in gerontology must provide explanations for both the continuities and the discontinuities of life span development. Perhaps theory development in the area of everyday competence can serve as a particularly useful example of how explanations may be found that showcase the remaining vitality of the aging individual as a contributing member of the species and at the same time explain the transformations in behavior and context that characterize the later stages of the life course.

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